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Science and Air Warfare

NO scientist believes that it is possible to destroy great cities in a few hours. The modern aeroplane makes war more immediate and dangerous to those who in 1914 could view proceedings comfortably and safely from the windows of their club: it brings about a good deal of disorganization, and in a small over-centralized country like England might interfere calamitously for a time with the distribution of food: but it cannot come near fulfilling those prophetic threats of destroying London, or Paris, or Berlin.

To talk of an air war destroying European civilization itself is nothing but hysterical panic. It is simply a question of matter and energy; fortunately, as it turns out, man can still do comparatively little material damage to the world. Imagine that London was suddenly stricken with a plague so fatal that, in the interests of the rest of humanity, the town actually had to be demolished—demolished in a real physical, and not in a panicking political sense. It would take the combined air forces of the world, working from bases in Kent and Surrey (instead of hundreds of miles away), unopposed (instead of being met by at least three different sorts of defences), equipped with all the bombs on earth, a time which could not conceivably be less than weeks and would be more likely to run into many months.

For the last twenty years the dangers of air warfare have been consistently exaggerated. The horror has caught hold of the imagination of people all over the world: so much so, that the threat of violence looks like becoming enough to settle

the world's affairs. The horror persists, despite all reason, even despite experience. The fear of poison gas dominated many people's minds for years. Haldane told them that no new poison gas had been discovered since the eighties, that it was an expensive, inefficient means of killing, and very unlikely to be used: but still the fear stayed. It has not disappeared yet.

Scientists have always known that the most real danger came from bombardment with high explosive. As soon as the general public were slowly brought (and it seemed almost reluctantly) to believe slightly less firmly that the entire population of London was likely to be asphyxiated in an afternoon, they seized with redoubled fervour upon the prospect of a city being bombed to pieces by high explosive in a week. It is still difficult to persuade many people otherwise. You can show them calculations: you can demonstrate to them how much damage a bomb does, and tell them how many tons of bombs could be dropped in the worst possible circumstances. You can give them concrete examples from Spain: you can compare the tons of bombs dropped on Barcelona with the number of casualties and the amount of material damage. But it has very little effect. People still cling to this faith that doomsday is coming. They believe that millions of people would be killed by attacks from the air.

It is worth repeating that all scientists know these estimates to be ludicrous exaggerations.

That is not to say that a war will be pleasant, or that we ought to look upon aerial attack as an act of nature which we need not and cannot guard against. There is a great deal which should be done immediately to defend ourselves against the bombing aeroplane. What is to be done can be divided into two different types of defence: (*a*) hiding from the bombs, (*b*) preventing the bombs being dropped, i.e. attacking the aeroplanes themselves. In both of these tasks scientists should have been used far more thoroughly than they have up to now: but it is not too late.

From the scientific point of view, hiding people safely from bombs is a fairly simple matter. With a population living close together, it is possible to contrive an underground shelter which gives absolute protection and can be reached by all the population within the time limit of the warning. Finsbury is a good example of such a district, and the Finsbury deep shelter an admirable example of its kind. This sort of shelter should be built in all similar urban districts. This step should be taken at once. The objections are frivolous and not worth the attention of responsible men.

A difficulty arises, however, as soon as you pass from the urban districts to a less compactly populated suburb. The point is soon reached when a large number of the district cannot reach the shelter before the raid has begun; and in such districts, and in all widely scattered areas, deep shelters are not practicable methods of defence. Naturally, a raid on such places would be nothing like as effective as on an unprotected Finsbury, and in suburbs, or in the country, trenches and steel shelters give valuable protection. With deep shelters in the towns, particularly in London,

air raids would cease to be a menace; and, as soon as one or two had spent themselves with little result, they would merely stiffen the spirit of the English people.

The second type of defence, devising new methods of attacking the aeroplanes themselves, demands the immediate use of the best scientists in the country. A certain amount of research is being done under the War Office and the Air Force. But it is not being treated seriously enough. These are not normal times; the problem is urgent: there is an imperative need for organization, a sum of money negligible as military expenditure goes (say £100,000 or £200,000), and a faith that the problem can be solved. Many scientists have no doubt that it can, and in quite a short time. Lord Rutherford, the greatest and most realistic of English physicists, had none. About a year before his death, in 1937, he said that within a few years it should be possible to bring down such an immense proportion of attacking aeroplanes as to make air warfare not worth the candle.

That view is shared by many of the best and most inventive minds in England to-day. Somehow, by the "air mines" Mr Wells was describing the other day, or in some other fashion, aeroplanes can be stopped. It needs the organization of a team of our best scientists, and a tenth of the cost of a single submarine. If it were done, it would at last let science get back to its proper work.

THE EDITOR

The Drum of Xico, illustrating Mr Rodney Gallop's article "A Pagan Cult Survives in Mexico", on p. 218

The picture on the cover is also taken from this article, and shows a shaman cutting vegetation figures out of paper. The photographs were taken by the author.

A Pagan Cult Survives in Mexico

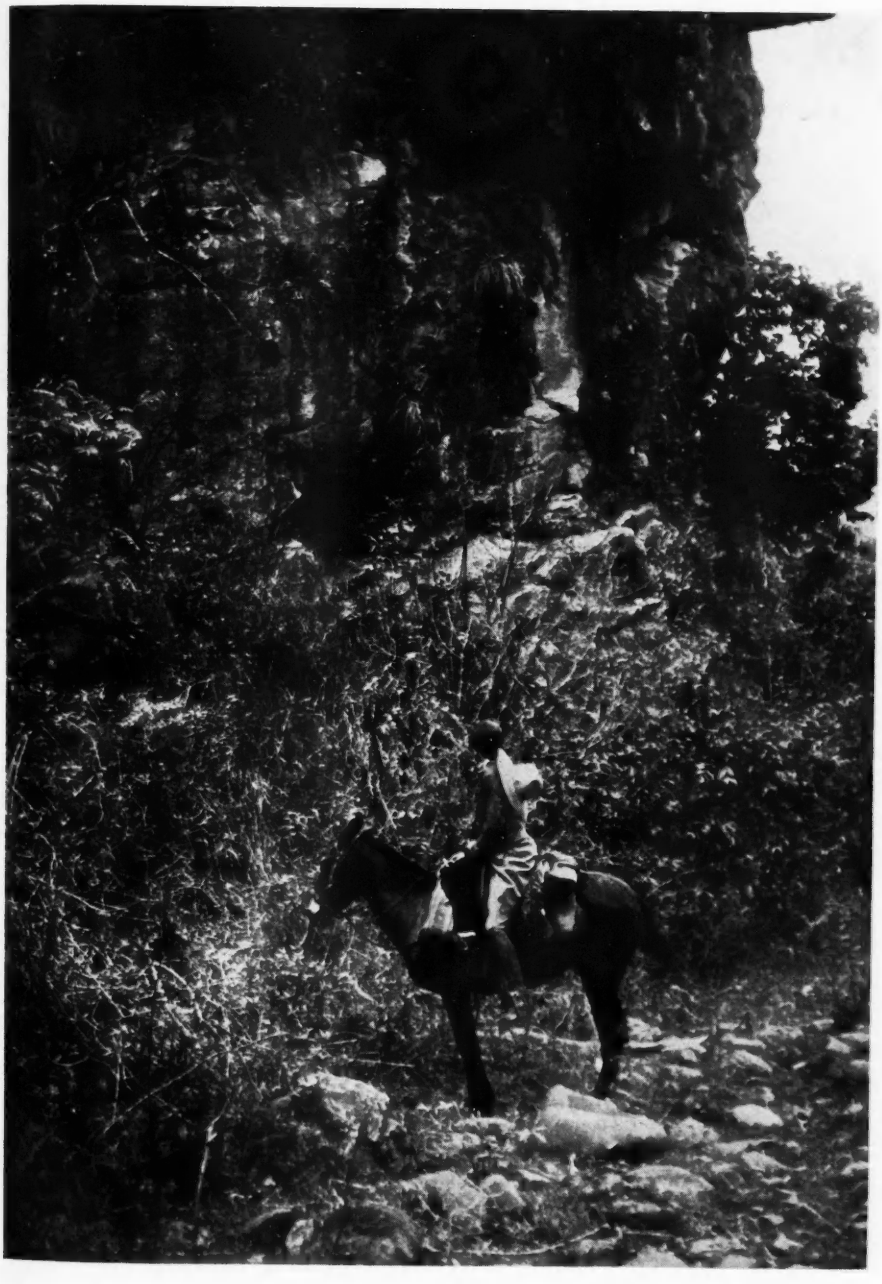
By RODNEY GALLOP

THE religion of Ancient Mexico, as revealed by archaeological remains, pre-Cortesian manuscripts and early Spanish accounts, such as those of Sahagún, Durán and Torquemada, reflects a state of extraordinary confusion. The Aztec Olympus was overcrowded with innumerable gods and goddesses whose attributes and spheres of influence overlapped in the most disconcerting manner. It seems almost as though the primitive inhabitants of the Valley of Mexico were always ready to welcome a new divinity without ever throwing over an old one. Wave upon wave of rude, hunting tribes poured down from the north, conquered the more advanced agricultural tribes and then proceeded to assimilate their civilization, fusing distinct religious systems, and worshipping, as Captain T. A. Joyce puts it in his *Mexican Archaeology*, "the rain- and fertility-deities of the agricultural peoples; the stellar war- and hunting-gods of the nomadic tribes who were regarded in the light of personal leaders; and the omnipotent creating-gods, such as Tonacatecutli and Tezcatlipoca, common to both".

Amid all this complexity there was one unifying influence. The Aztec religion was principally a fertility cult, however highly developed, and all its ritual, even including the detestable custom of human sacrifice, was aimed at securing a constant supply of food by ensuring the twin blessings of sunshine and rain, either directly by sympathetic magic or indirectly by the propitiation of sun, rain and earth divinities.

The relatively advanced civilization of the Aztec Empire, which was carried far and wide by military conquest, can be compared in some ways with the Roman Empire. Pursuing the parallel a little further, the Maya and Aztec religions can be compared with those of Greece and Rome. As Sir James Frazer has shown in *The Golden Bough*, the religions of Greece and Rome were developed out of a primitive agricultural fertility cult or series of cults widely distributed through Europe. It is not unreasonable to suppose that something similar may have occurred in Indian Mexico. Montezuma ruled over vast regions, the Indian tribes of which had not attained (and have not attained to-day) a state of civilization comparable with that of the capital. Their religious conceptions must have remained simpler, more rudimentary and closer to the primitive earth cults from which the worship of Quetzalcoatl and other divinities was derived.

Unfortunately, the sources on which we base our knowledge of the Aztec religion are silent on this point, and it would be possible to reconstruct its character only from the study of pagan survivals still existing to-day. The difficulty, however, is that the Catholic Missionaries who accompanied and followed the Conquest carried out their task so efficiently that uncontaminated pagan belief and practice are far more difficult to find in Mexico than among the Indians of the United States of America. There were many points in common between the two religions, such as the cross which in Mexico symbolized the four cardinal points. While these facilitated the work of the missionaries in winning over the Indian to nominal Christianity, they imbued the catholicism of the Indian with a remarkably pagan flavour and render peculiarly difficult the task of the investigator who seeks to analyse any surviving ceremony in order to determine which of its features are Christian and which pagan in origin. Thus Mr Bernard Bevan, who found the Chinantecs still materially and spiritually in the first century of the Conquest, could



The Cueva del Aguila, *where pagan ceremonies are held*

A cave near Atla used for pagan ceremonies. Offerings can be seen at the back, and to their right tables with shelters of petate *matting, used for divination ceremonies*

discover no survivals of recognizable paganism among them.

Until lately, indeed, no such survivals had been found except in the north-western Sierra Madre among the Tarahumara and Huichole Indians who are more closely related to those of the United States than to those of southern Mexico, and who were probably never in close contact with the Aztecs. Quite recently, however, two or three investigators, working among remote tribes in southern Mexico, have discovered ancient survivals, the existence of which had previously been scarcely suspected, and which may throw some light on the earliest forms of Amerind religion. Mr Bernard Bevan has been more fortunate among the Mazatecs than he was among the Chinantecs. M. Guy Strasser-Péan has made interesting discoveries among the Huaxtecas. Among the Tlapanecas Dr Schulze Jena stumbled upon a crypto-pagan cult on which he obtained much information until his informant mysteriously vanished and it proved necessary for him to depart with all speed. Among the Tepehuas of Hidalgo Dr Robert Gessain had the good fortune to discover a pagan shaman who had repented of his ways and gave Dr Gessain and myself a remarkably full account of the cult as practised in Huehuetla. Lastly, with the aid of Mr Weitlaner and the late Mrs Larsen, I was able so to gain the confidence of the Otomis in a village in the Sierra de Puebla that I learnt much about their pagan cult and even attended two of its rites as described in my book *Mexican Mosaic*.

When all these materials are available in printed form it will be possible to build up a general idea of the essence of an earth cult which probably underlies the later and more advanced religious beliefs of Mexico.

Of particular interest is the fact that

Offerings in the cave shown on p. 220. *These are of cut paper and* maxochiles *of stick wound round with maize husk and stuck with marigold blossoms*

everywhere this paganism is called *brujería* (literally "witchcraft") in Spanish, and its exponents *brujos* (witches), thus affording circumstantial evidence in favour of Dr M. A. Murray's theory that European witchcraft was not malign in its essence but represented the underground survival of a pre-Christian pagan agricultural fertility cult.

Among the Huaxtecas M. Strasser-Péan found a deep-rooted notion that the earth supported man's presence grudgingly if not unwillingly. She was naturally irritated by his diggings and delvings into her surface in the pursuit of agriculture, but she tolerated them in the certain knowledge that she would devour all men in the end. Accordingly, the Indians, if they were anxious in regard to the health of some member of their family, would approach her through a shaman and would endeavour to placate her by suggesting that, since she was sure of eventually devouring the afflicted person, she should for the present content herself with the hen or turkey which they offered in sacrifice. Similarly, they would endeavour to bribe the earth to devour an enemy sooner than she would otherwise have done.

In the Otomi village of San Pablito I found a cult centring round Shimhoi, the Holy Earth, and also round more local earth divinities such as the *Dueño del Cerro* (Lord of the Mountain) who was conceived as inhabiting the steep peak which rises straight up behind the village. I was further told that "within the earth dwells an idol called Kho-kan-gu". The literal Otomi translation of this name is "well-disposed ear", which fits in well with the propitiatory nature of the cult. Here, I was able to attend a nocturnal ceremony of homage to Shimhoi, and an oracle in which the *Dueño del Cerro* and a mysterious

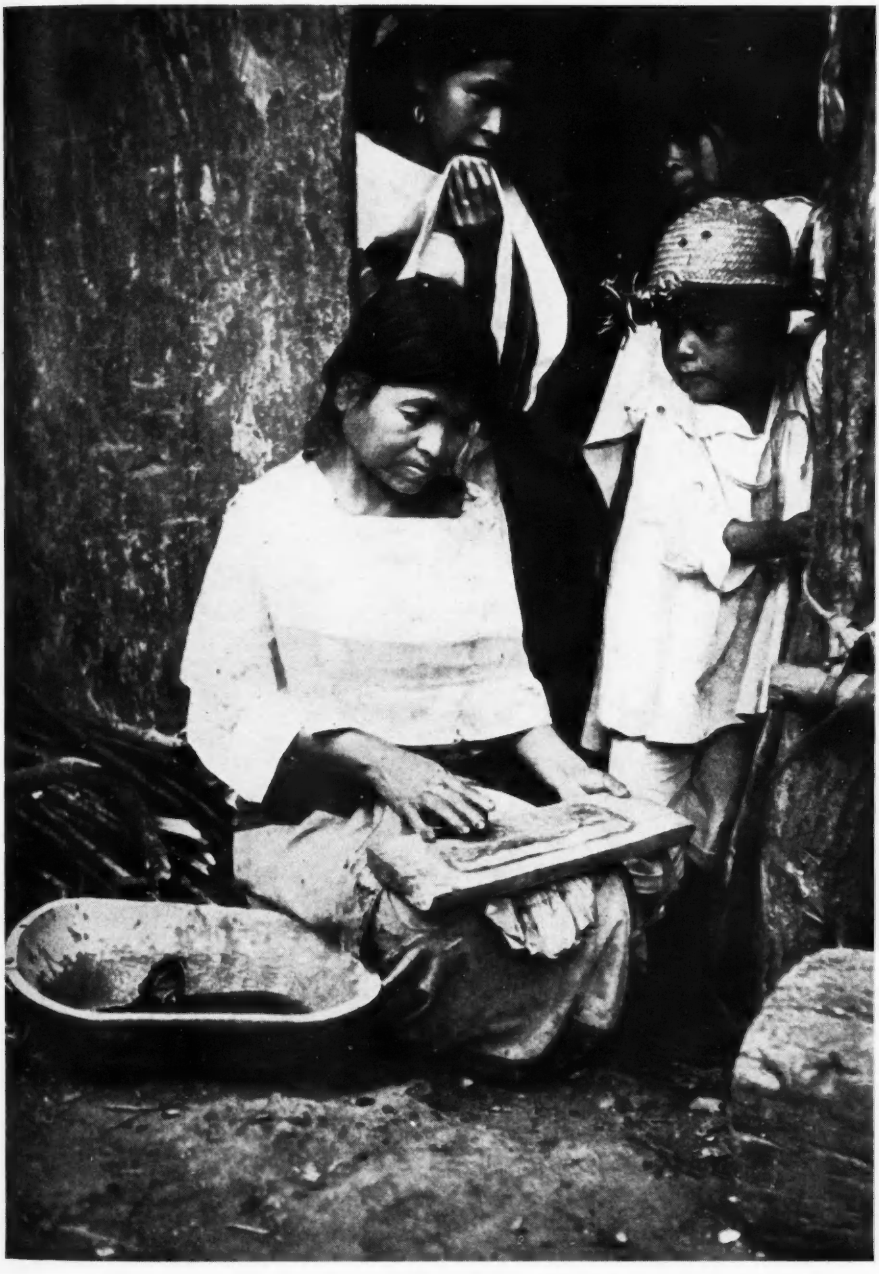
An Otomi shaman with his little daughter

personage called Santa Rosa spoke through the lips of a shaman intoxicated with a powerful drug. The details of such ceremonies are regulated by well-established and carefully observed tradition. Song, dance and instrumental music on the fiddle and guitar all play their part in the proceedings. They are regarded in the light of offerings, which also take a more material form. An invocation to Shimhoi which I collected at San Pablito describes how the hierophant offers wax, paper, flowers, combs, soap, silken thread and a turkey "to kill, that its blood may be a delicacy to thee". Chocolate and cigarettes are also among the oblations, but the most important and the most widespread are the wax candles, flowers, eggs, chickens, turkeys and cut paper. I have come across no trace of any survival of human sacrifice, although at Huehuetla there is a recollection of the sacrifice of virgins in the Huaxteca country with circumstantial details which may or may not be due to uncontaminated folk memory, and at Pahuatlan there is a tradition that the Otomis of San Pablito used to sacrifice children by drowning them in the river "a hundred years ago". It by no means follows that human sacrifice, which was carried to such lengths by the Aztecs, was not a later extension of the original cult which may in its beginnings have contented itself with floral and animal offerings.

The floral offerings include invariably the *cempoalxochitl*, a member of the marigold and arnica families, the golden blossoms of which are cultivated especially for ritual purposes, being also strewn on the tombs in the Christian observances connected with All Souls' Day. Little wands of stick bound round with maize husk or splayed out fanwise into three or five arms are stuck with the blooms, carried by dancers, and left as offerings. I have found these *maxochiles*, as they are called, in the *Cueva del Aguila* near Pahuatlan, and in another cave near Atla where the Nahua shamans hold their ceremonies: and I have seen them carried by the ritual dancers of San Pablito.

At San Pablito and Huehuetla bees are kept purely for wax, and no use is made of the honey. The Cueva del Aguila contained, in addition to candle-ends, a human figure in wax, about four inches high, with no indication of its sex or of the purpose which it was intended to fulfil.* Hens and turkeys are sacrificed either "alive" or "dead". In the first case they are allowed to die a natural death: in the second their throats are cut and they are drained of blood.

* Now in the possession of the Ethnological Museum at Stockholm.



Making pre-Spanish bark paper, which is used exclusively for magical ceremonies

Strangest of all are the offerings of cut paper, which are mentioned as early as in the sixteenth century in Padre Motolinia's list of pagan offerings. In its simplest form, as I found it for instance in the Atla cave, it consists of coloured tissue paper, factory made, folded and cut into geometric patterns which may or may not have a symbolic meaning. At another cult place which I was shown near Tlapacoyan, the offerings included *ocotes*, straight strips of pinewood with strips of different coloured paper fastened to them with a bow. At San Pablito both this factory-made paper and bark paper home-made in pre-Conquest fashion, are used for cutting out little human figures which are put to a wide variety of purposes connected with the cult. I have seen this paper at every stage of its manufacture and use. It is of two kinds: a light paper made from the bark of the *jonote* and *moral* trees, with "white magic" associations; and a darker paper of *xalamal* bark with more sinister implications. The bark is allowed to soak in lye-water. Next, it is pounded on a wooden board with a stone utensil shaped like a cake of soap. When dry it is folded in half and cut by a shaman with factory-made scissors into human figures, the female distinguished from the male by the zigzag hair standing straight up from her head. Three slits furnish them with eyes and mouth of a curiously sinister expression. Such dolls are used for a variety of purposes. They are buried with the seed at the winter sowing, kept in the huts as household gods, or used for the cure of sickness.

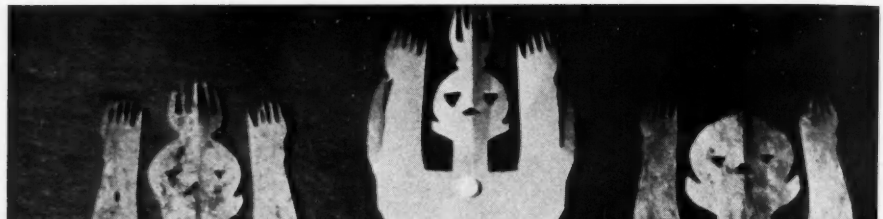
Even stranger are the figures made of coloured, factory-made paper. From their sides sprout excrescences in the form of the particular crop which they are intended to symbolize. This symbolism is extended to the colours of the paper, of which two or more layers are superimposed. Thus the maize figure is green and white and the chilli pepper figure green, white and red. A honey doll, white for the wax and yellow for the honey, has bees flying like birds from its sides.

Though most ceremonies are held in the open fields, round trees, in caves, near lakes or on mountain-tops, small stone buildings in the villages called *oratorios* serve as chapels of the cult, each in charge of a shaman. At Huehuetla each shaman has an archaeological stone idol in his care. Near San Bartolo is a cave with an idol to which many Otomis go in pilgrimage in February. San Pablito once had an idol on its mountain-top, but it was stolen by the people of San Nicolas and has never been recovered. The objects of its cult, therefore, are the coloured paper dolls. Mounted on little sticks to give them the requisite firmness, they are kept in a coffer in the *oratorio*, except when they are brought out for some ceremony, such as the one which I witnessed, when they are dressed up in miniature garments complete with the ear-rings and embroidery on the blouses of the female dolls.

Farther north, in the State of Hidalgo, a friend of mine once stumbled on a pagan sanctuary among the woods of a mountain side. There were two lines of paper figures hung up, one row of which had bits of meat thrust into their paper mouths. An Indian informant told my friend that this was the summer sanctuary. The winter one was down in the village and had idols of stone. To an enquiry about what the stone idols were fed with he returned no answer.

In a number of villages the shamans preserve ancient pre-Conquest *teponaztli* drums, some of them carved, which it is extremely difficult to see, since they are regarded almost as totems. One at Xolotla, a Nahua village, is given the highly significant personal name of Tlalticpactli, meaning "the earth", which suggests that it is regarded almost as a personification of the earth cult. To the one kept in a cave at San Pablito, which is only played about once in five years, offerings are made and its pardon is craved when it is moved. Another which I was able to photograph at Xico is carved in the shape of a monkey, and is played at an obsolescent festival in honour of Xochipilli, the Aztec god of

Making the dark form of the pre-Spanish bark paper, which has "black magic" implications



Paper figures from San Pablito. Left and right, female and male figures cut from the light-coloured bark paper. Centre, a maize figure cut from commercial paper

song, dance and feasting, who is sometimes personified by a monkey in ancient mythology. This is the only instance in which I have found traces of the worship of an ancient Aztec god by name.

Besides being the priests of the cult for the purpose of mediation with the unseen world, the shamans are also medicine men in the strictest sense of the word, and claim to be able to cure diseases of all kinds. Presumably they are successful in the majority of cases, for imposture is punished with imprisonment at San Pablito. Their methods are very varied, including rites of propitiation to the earth; chants conjuring Montezuma, here conceived to be the "Lord of Sickness", to depart; the transference of the disease to a dark paper figure which is then burnt and substituted by one of light paper; and the time-honoured system of sucking out or otherwise "extracting" small objects alleged to be the cause of the trouble. In a particular case which came to my notice, a hen was killed, wrapped in dark bark paper and carried away in a *huacal* crate by a friend of the patient, accompanied by the shaman singing to the music of fiddle and guitar. On the outskirts of the village the crate was thrown away and the participants crossed themselves and rubbed themselves with cleansing herbs which they also threw away.

On occasion the shamans dabble in black magic. A method of laying spells used at San Pablito is as follows: A doll is made

to represent the intended victim. In the body little stones taken from the river are inserted and made fast with wax. A pin is stuck in the neck, and a splinter of orange wood in the head. The doll is then either thrown into the river or buried in the victim's field or in the sacred hill behind the village. Another method is to put the doll on a plate together with a dead chicken, a candle, and eggs which have been painted with stripes and a cross and covered with lime. The plate is then disposed of in the same way. As the doll decomposes the victim will sicken and die, unless he consults some other shaman who can ascertain by divination the manner in which the spell has been laid and perform the same ritual by inversion.

The relationship between the old cult and Christianity is strange, yet characteristically Indian. These people are all nominal Roman Catholics. There are churches in their villages which they attend on the rare occasions when a priest visits them. This may be only once a year for the village *fiesta*, which at San Pablito falls on the Sunday after Easter. Even the shamans attend church, for there is no power, whether Christian or pagan, which they are averse from harnessing to their ends. The principal shaman of Xolotla went so far as to send to Mexico City for a priest's vestments and a biretta in which to perform his unhallowed rites. Other festivals are celebrated in a Christian manner, notably that of All Saints and All Souls, devoted here as elsewhere to the dead. This desire to make the best of both worlds is shared by the people, but their greater devotion is to the older faith, if one may judge from the sums which they expend on it. A ceremony of homage to the earth, such as I saw, may cost the individual who sponsors it the equivalent of seven or eight pounds. Once every five or six years every man, woman and child in San Pablito joins in the *fiesta grande* (last held in September 1936) on the sacred hill where the idol used to stand, at a cost to the community of about fifty pounds. One must have lived among these people and seen their poverty to realize how deep a devotion this betokens to the ancient religion of their forefathers.

A Survey of Pneumonia Treatment

By Sidney Oldham

In view of the wide lay interest in medical matters to-day, a survey of progress in the treatment of lobar pneumonia may not be out of place. Although nothing spectacular like the treatment of respiratory failure in infantile paralysis by the so-called "iron lung" has evolved, real advances in treatment have been made.

Pneumonia is among the most serious infectious diseases affecting mankind. It is prevalent in all civilized countries. In Manchester alone, 1268 cases occurred in 1937, of which 420 died. It affects men twice as frequently as women. It is particularly common, and particularly fatal, in infants and in the elderly. In alcoholics and in pregnant women, the disease is especially dangerous.

Its onset is sudden, with cold sharp chest pains and brown sputum. Profound toxaemia or poisoning and delirium rapidly follow. Breathing is rendered difficult by excessive fluid secretions accumulating in the lungs, and the patient dies usually of oxygen lack, literally drowned in his own lung fluids.

Fortunately, now, the old statement that "pneumonia will run its course uninfluenced by medicine, and no known means can cut short that course or abort it", is

no longer true. Modern type-specific serum has greatly reduced the mortality rate, and prognosis is much more favourable.

Many bacteria, such as those causing diphtheria and tetanus, produce their harmful effect by elaborating poisonous substances—toxins—which are poured into the victim's blood stream. Normally the human body has a defence system which is able to resist these bacteria and neutralize their toxins, but when weakened by previous illness, cold, undernourishment, etc., this resistance to infection is lowered and the pathogenic disease-producing bacteria gain a foothold.

By giving a healthy person a dose of bacteria not quite sufficient to produce real illness, the body defences are mobilized and strengthened, and a high degree of resistance or immunity to that disease results. This is called active immunity, the patient "conscripting" and organizing his own defence system. Alternatively an animal such as the horse may be so treated, and its blood, now richer than normal in antidotes to the bacteria and their poisons, withdrawn and given to a patient to augment his own body defences against the disease. Such is passive immunity—the patient not assisting in making antidote substances, just receiving ready-made ones—and this is usually shorter lived than active immunity. This method is the basis of all serum treatment of diseases. The blood serum of animals, usually horses, which have been immunized against a certain disease, when given to a patient with that disease, holds it in check; the antitoxins in the serum neutralize the bacterial poisons in the patient's blood and thus ease the task of his fighting forces, which then are more easily able to overcome the infection. von Behring introduced such serum treatment for diphtheria with now historic success, the reduced mortality rate being a monument to the method.

The first anti-pneumonia serum was produced about 1897, but not until 1909 was a really effective product available. Then Neufeld and Handel prepared a polyvalent serum which gave a number of good results. It was found that the *Diplococcus*, the organism which produced pneumonia, existed in a number of different strains or types (as, for example, the varieties or strains of lupins in the garden), the virulence of which differed. Anti-sera were usually made from a mixture of these types, i.e. polyvalent sera. A more effective and concentrated serum was devised by Felton in 1924, but frequent failures from the use of such serum tended to bring it into disrepute.

However, workers in the Rockefeller Institute showed that anti-serum was effective only against the same type or strain of *Pneumococcus* and had little action on other types. For example, the commonest types are 1 and 2. A type 2 serum would be largely useless in a type 1 infection. This explained the poor results, it being realized that in using a polyvalent serum only part was being effective and so actually inadequate doses were being given.

Because of this specificity of the anti-sera, it is necessary to ascertain the type of *Pneumococcus* responsible for the infection so that the correct serum could be used. This usually meant sending the patient to hospital where a bacteriological examination of the sputum could be made. As the early use of serum is essential, such delays in diagnosis might easily ruin chances of success. So, in order to avoid delay, the "typing" of the bacteria responsible for the disease was often omitted, and polyvalent preparations injected as early as possible. As, then, even with massive doses of serum, only a fraction was usually effective, results were disappointing, and the reputation of serum treatment suffered until the importance of type-specific therapy was realized.

Most pneumonias are types 1, 2 or 3, and sera for these were soon available. However, matters were again complicated by the recognition of some thirty more types of *Pneumococcus*. Specific sera for these, too, are available now. "Typing" obviously was now a considerable problem.

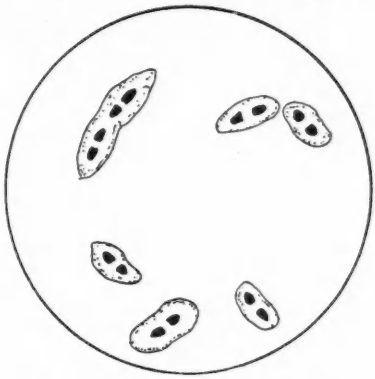
Fortunately, 60 % or so cases are 1 or 2 or a mixture of these, but the other types are met and must be recognized if serum treatment is to succeed.

Type I pneumococcus in sample of sputum mixed with type II rabbit antiserum. No reaction.

Recently, by the work of Neufeld and Sabin, a rapid and simple method of "typing" has been evolved. By means of this test even comparatively inexperienced workers can "type" a pneumonia in 5–10 minutes. Thus early diagnosis is ensured and specific treatment can be begun immediately with greatly increased chances of success—a notable advance.

The basis of this method is as follows.

The *Diplococcus* of pneumonia is surrounded by a fine gelatinous capsule ordinarily barely visible under the microscope. When to a sample of sputum containing such pneumococci, a type-specific anti-serum is added, typical changes occur in the capsules, which swell and develop a refractile appearance like ground glass. This "Quellung" phenomena is quite characteristic; the test is delicate and a positive result is unmistakable. The results of specific serum treatment depend on the type responsible for the disease. Thus, in 1200 cases of type 1 infection treated with serum the mortality rate was 15 %, compared with 25 % in a group treated without serum. The mortality was therefore decreased by 40 %. With 700 cases of type 2 infection, the mortality was reduced from 37 to 30 %; that is, a reduction of 19 % in mortality. The average mortality of all



Type I pneumococcus in sample of sputum mixed with type I rabbit antiserum: "Quellung" reaction showing. Magnification × 1000.

cases fell nearly 50 % after the introduction of serum treatment.

Meanwhile, other methods of treating pneumonia, by synthetic drugs, have been tried. A chemical compound, known as S.U.P. 36, was found to be beneficial in many respiratory infections coupled with fever. Injected intramuscularly good results were obtained from it in such conditions as influenza and bronchitis. For bronchial pneumonia it seemed almost a specific cure, and in lobar pneumonia fever was relieved and uneventful recovery usually followed. The drug appears to act by building up and augmenting the body defences.

A further possibility in the treatment of pneumonia by chemical means appeared with the discovery of the sulphanilamide drugs, e.g. Prontosil. Whilst, however, these gave excellent results against streptococcal infections they were relatively useless for pneumonia. A great deal of research ensued and finally a substance, 2-sulphanilyl-aminopyridine or M and B 693, was produced. It has been found to be active against not only streptococci but also

meningococci and pneumococci. Evans and Gaisford have used it for pneumonia with quite promising results. The temperature falls rapidly and the patient's condition improves markedly.

Care must be exercised in the use of the drug. Although it is less toxic than sulphanilamide some individual reactions such as malaise, headache, nausea, and anaemia may occur. Strict dietary control is essential, and all foods and purgatives containing sulphur should be avoided.

The drug acts apparently by destroying the capsules of the *Pneumococcus*, thus rendering their destruction by the leucocytes of the blood easier.

When M and B 693 is used, routine application of poultices to the chest and administration of stimulants is often unnecessary.

Oxygen, too, is seldom required unless there is acute respiratory distress. Incidentally the administration of oxygen is by no means the last desperate resort that many believe. Oxygen is most valuable in the early stages of the disease when it relieves the strain on the heart and eases breathing. Its early use indeed often prevents the increase of lung congestion which is so serious a complication of lobar pneumonia, and thereby materially increases chances of recovery.

Of 100 cases treated by Evans and Gaisford with M and B 693, only eight died, whilst in a control series the mortality was 27 %. The cases were of various types and the response to treatment did not seem to depend on the type of infection. Since this report many others have appeared describing the same dramatic improvement in a great number of patients and the same extraordinary decrease in mortality.

Recently combinations of M and B 693 and serum treatment have been used. There seems little advantage over the use of M and B 693 alone, but it is too early yet to give any opinion.

Mr Tompkins in Wonderland

By Professor G. GAMOW

Dream VI: Last Adventure*

WHEN Mr Tompkins came down to have his breakfast in the long glass verandah of the hotel, the morning after his arrival at the seaside, a great surprise awaited him. At the table in the opposite corner sat the old Professor and the girl he had met in the train; the girl was cheerfully relating something to the old man, and glancing often in the direction of the table where Mr Tompkins was sitting.

"I suppose I did look very stupid, sleeping in that train", thought Mr Tompkins, getting more and more angry with himself. "And the Professor probably still remembers the stupid question I asked him about getting younger, instead of cashing his cheque. But this at least will give me an opportunity to become acquainted with him now and ask about the things I still do not understand." He did not want to admit even to himself that it was not only the conversation with the Professor he was thinking about.

* In this story all world constants are dancing a "square dance".

"Oh, yes, yes, I think I do remember seeing you at my lectures", said the Professor when they were leaving the dining room. "This is my daughter Maud: she is studying painting."

"Very happy to meet you, Miss Maud," said Mr Tompkins, and thought that this was the most beautiful name he had ever heard. "I expect these surroundings must give you wonderful material for your sketches."

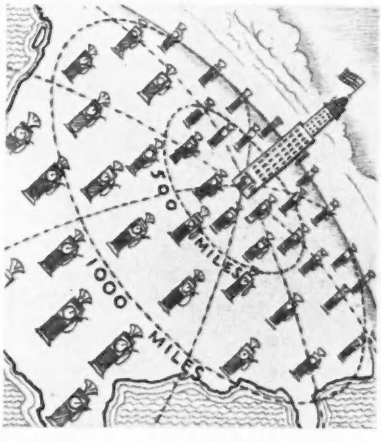
"She will show them to you some time", said the Professor, "but tell me, did you gather much from listening to my lectures?"

"Oh, yes I did, quite a lot, and I feel about the expanding universe as if I was in it myself."

"Well, you *are* in it, as a matter of fact", said the Professor, who did not understand what he meant. "But do you, for example, understand the difference between the positive and negative curvature of space?"

"Daddy," said Miss Maud, pouting her lips, "if you are talking physics again, I think I will go and do some work."

"All right, girlie, you run along", said the Professor, plunging himself into an easy chair. "I see you did not study mathematics much, young man; but I think I can explain it to you very simply, taking, for simplicity, the example of a surface. Imagine that Mr Shell—you know, the man who owns the petrol stations—decides to see whether his stations are distributed uniformly throughout some country, say America. To do this, he gives orders to his office, somewhere in the middle of the country (Kansas City is, I believe, considered as a heart of America), to count the number of stations within one hundred, two hundred, three hundred and so on miles from the city. He remembers from his school days that the area of a circle is proportional to the square of its radius, and expects that in the case of uniform distribution the number of stations thus counted should increase like the sequence of numbers 1; 4; 9; 16 and so on. When the report comes in, he will be very much surprised to see that the actual number of stations is increasing much more slowly, going, let us say, 1; 3·8; 8·5; 15·0; and so on. 'What a mess,' he would exclaim; 'my managers in America do not know their job. What is the great idea of concentrating the stations near Kansas City?' But is he right in this conclusion?"



"Is he?" repeated Mr Tompkins, who was thinking about something else.

"He is not", said the Professor gravely. "He has forgotten that the earth's surface is not a plane but a sphere. And on a sphere the area within a given radius grows slower with the radius than on a plane. Can't you really see it? Well, take a

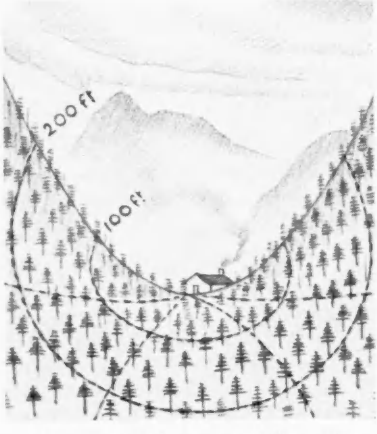
globe and try to see it for yourself. If, for example, you are on the north pole, the circle with the radius equal to a half meridian is the equator, and the area included is the northern hemisphere. Increase the radius twice and you will get in all the earth's surface; the area will increase only twice instead of four times if it were on a plane. Isn't it clear to you now?"

"It is", said Mr Tompkins, making an effort to be attentive. "And is this a positive or a negative curvature?"

"It is called positive curvature, and, as you see on the example of the globe, it corresponds to a finite surface having definite area. An example of a surface with negative curvature is given by a saddle."

"By a saddle?" repeated Mr Tompkins.

"Yes, by a saddle, or, on the surface of the earth, by a saddle pass between two mountains. Suppose a botanist lives in a mountain hut situated on such a saddle pass and is interested in the density of growth of pines around the hut. If he counts the number of pines growing within one hundred, two hundred, and so on feet from the hut, he will find that the number of pines increases faster than the square of the distance, the point being that on a saddle surface the area included within a given radius is larger than on a plane. Such surfaces are said to possess a negative curvature. If you try to spread a saddle surface on a plane you will have to make folds in it, whereas doing the same with a spherical surface you will probably tear it if it is not elastic."



"A mountain hut in a saddle pass"

"I see", said Mr Tompkins. "And you mean to say that a saddle surface is infinite although curved."

"Exactly so", approved the Professor. "A saddle surface extends in all directions infinitely and never closes on itself. Of course, in my example of a saddle pass the surface ceases to possess negative curvature as soon as you walk out of the mountains and go over into the positively curved surface of the earth. But of course you can imagine a surface which preserves its negative curvature everywhere."

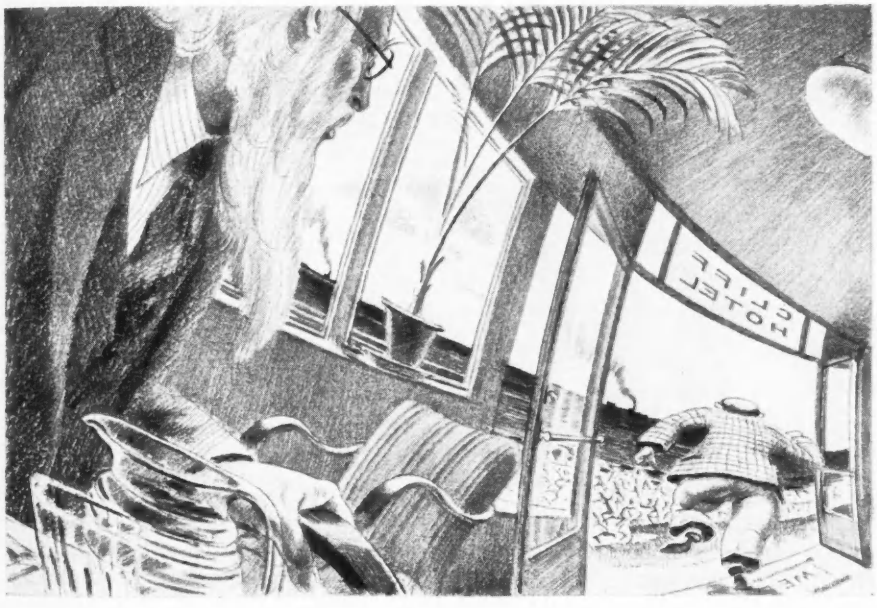
"But how does it apply to a curved three-dimensional space?"

"Exactly in the same way. If you have some objects distributed uniformly through space, I mean in such a way that the distance between two neighbouring objects is always the same, you have to count their number within different distances from you. If this number grows as the square of the distance, the space is flat; if the growth is slower or faster, the space possesses a positive or a negative curvature."

"Thus in the case of positive curvature the space has less volume within a given distance, and in the case of negative curvature more volume?" said Mr Tompkins with surprise.

"Just so", smiled the Professor. "Now I see you understood me correctly. To investigate the sign of the curvature of the great universe in which we live, one just has to do such counts of the number of distant objects. The great nebulae, about which you have probably heard, are scattered uniformly through space and can be seen up to the distance of several thousand million light years; they represent very convenient objects for such investigations of the curvature of the world."

"And so it comes out that our universe is finite and closed in itself?" said Mr Tompkins, remembering his very first dream and the strange accident with the return of the Professor's note-book.



"Careful!" shouted the Professor

"Well," said the Professor reflectingly, "so it was usually accepted, and, as a matter of fact, I thought so myself when I was delivering my lectures. However, just a few weeks ago I read an article in *Nature*, in which two young physicists suggest that this opinion is erroneous, and that the universe is actually infinite, possessing a negative curvature. And I think they are right."

"Thus we live on an infinite expanding saddle, and the expansion will never turn into a contraction to squeeze us and our children to death", exclaimed Mr Tompkins with some relief. "Then there is something to live for!"

He turned to pour some water into his glass, but although he emptied the contents of a large water jug, the glass seemed to be almost empty. "The space inside this glass has probably a large negative curvature", he heard the voice of the Professor saying, "and has immense volume inside a small surface. If you took a glass with a large positive curvature inside, a few drops would probably fill it to the edge. I guess some funny changes start in the curvature of space round here! Something like a 'space quake'."

And really, very unusual changes seemed to take place around them: one end of the lobby became extremely small, squeezing all the furniture in it, whereas the other end was growing so large that, as it seemed to Mr Tompkins, the whole universe could find room in it. A terrible thought pierced his mind: what if a piece of space on the beach, where Miss Maud was painting, were torn away from the rest of the universe. He would never be able to see her again! When he rushed to the door he heard the Professor's voice shouting behind him. "Careful! the quantum constant is getting crazy too!" When he reached the beach it seemed to him at first very crowded. Thousands of girls were rushing in disorder in all possible directions. "How on earth am I going to find my Maud in this crowd?" he thought. But then he noticed that they all looked exactly like the Professor's daughter, and he realized that this was just the joke of the uncertainty principle. The next moment the wave of anomalously large quantum constant had passed, and Miss Maud was standing on the beach with a frightened look in her eyes.

"Oh, it is you!" she murmured with relief. "I thought a big crowd was rushing on me. It is probably the effect of this hot sun on my head. Wait a minute until I run to the hotel and bring my sun hat."

"Oh, no, we should not leave each other now", protested Mr Tompkins. "I have an impression that the velocity of light is changing too; when you return from the hotel you might find me an old man!"

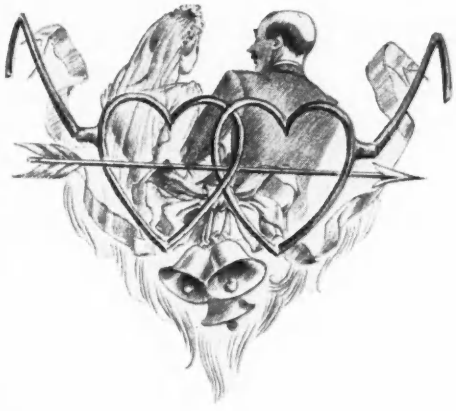
"Nonsense", said the girl, but still slipped her hand into the hand of Mr Tompkins. But half-way to the hotel another wave of uncertainty overtook them, and both Mr Tompkins and the girl spread all over the shore. At the same time a large fold of space began spreading from the hills close by, curving surrounding rocks and fishermen's houses into very funny shapes. The rays of the sun, deflected by an immense gravitational field, completely disappeared from the horizon and Mr Tompkins was plunged into complete darkness.

A century passed before a voice so dear to him brought him back to his senses.

"Oh," the girl was saying, "I see my father sent you to sleep by his conversation about physics. Wouldn't you like to come and have a swim with me, the water is so nice to-day."

Mr Tompkins jumped from the easy chair as if on springs. "So it was a dream after all", he thought, as they descended towards the beach. "Or does the dream just begin now?" .....

Their wedding was celebrated quietly, and they lived happily ever after.



[*With this relatively happy ending Professor Gamow's accounts of his hero's dreams come to an end. The dreams themselves, together with the professorial lectures that caused them, will be published in book form by the Cambridge University Press.* ED.]

The Chemistry of the Internal Combustion Engine

By A. R. UBBELOHDE

WHEREAS the development of the steam engine from kettle lid to turbine has been entirely due to engineers, advances in the design of the internal combustion engine, and especially advances in the aero engine, have been much more closely bound up with chemical discoveries. The development of new lubricants and of special alloys are obvious instances, but the chief improvement of the last few years has been in providing new fuels. It has been estimated that the power of a modern aero engine would be halved if it could use only the fuels available ten years ago. The progress that has been made is a very mixed gain to humanity, but no modern air force can afford to neglect fuel research.

The source of power in an internal combustion engine can be described fairly simply. In the spark ignition (petrol) engine, a mixture of vaporized fuel and air is drawn in from the carburettor and compressed in the engine cylinders, and is ignited by a spark when the piston has almost reached the top of the compression stroke. When the fuel/air mixture explodes, the heat developed causes the burnt gases to expand, and the power of this expansion

is used to drive the engine. As in all other engines, only part of the heat can be converted into mechanical motion, the rest is lost in the hot exhaust gases, and to the air or water used to cool the cylinder walls. The most economical way of improving the spark ignition engine is to alter the design so as to increase the proportion of the heat of combustion which can be converted into power. A simple formula for the proportion of this heat of combustion converted into useful work is

Efficiency of engine
= Proportion of heat converted to work

$$= 1 - \left(\frac{v}{V}\right)^a,$$

where V is the volume of the cylinder swept out by the piston in a complete stroke, and v is the much smaller volume of the fuel/air mixture at the top of the compression stroke, just before sparking; a is a constant. In other words, the essential meaning of this formula is that since the volume V of the cylinder cannot be much increased, to keep down weight and space the only practical way of increasing the efficiency of the engine is to decrease the volume v, so as to increase the "compression ratio" V/v.

When the design of the engine is altered so as to increase the compression ratio, it is found in practice that beyond a certain limit (the highest *useful* compression ratio, H.U.C.R.) the efficiency no longer increases, and may even decrease. A loud knock is usually noticed at this stage. The occurrence of knock thus sets a limit to the efficiency of even the most modern engines. Petrols of different geographical origin differ markedly in their H.U.C.R. and tendency to knock, but since any petrol is a mixture of a large number of hydrocarbons it has been necessary to study the knocking tendency of every constituent in the pure state. A result of great importance emerging from this research is that different hydrocarbons differ widely in their tendency to knock. Amongst the paraffins, molecules in the shape of long chains of atoms have a very low H.U.C.R., whereas if the same number of atoms is bunched together in the molecule, rather like pips in a blackberry, an excellent fuel is obtained. In an extreme case the difference would be enough to add 100 m.p.h. to the speed of an aeroplane. Aromatic molecules, such as the benzene obtained from the distillation of coal, are likewise fuels with high H.U.C.R., giving good results even in the most modern engines.

The most direct outcome of experiments of this kind would be to produce the best possible hydrocarbon synthetically. At present it is not profitable to produce pure hydrocarbons in quantity, though the results would be striking. Active research is, however, being carried out on the catalytic conversion of the long-chain molecules present in certain petrols into bunched molecules so as to improve the quality of the fuel.

Further information on fuels has been obtained by physical and chemical investigation of processes actually occurring in a cylinder of an internal combustion engine. Three main problems which have to be solved are:

(1) The cause of the knocking noise and loss of power when the compression ratio is increased beyond the highest useful value for any selected fuel.

(2) The reason why the H.U.C.R. of a fuel is closely connected with its molecular structure.

(3) The reason why traces of metallic derivatives like lead tetraethyl (as used in "ethyl" petrol) have the valuable property of increasing H.U.C.R. and suppressing the tendency to knock, and why certain organic pro-knocks have a precisely opposite effect.

Direct information on the first problem has been obtained from measurements of the pressure and velocity of explosion waves in an engine cylinder. In order to measure the velocity of travel, the top of the cylinder is replaced by a pressure-resisting quartz window, and the contents

of the cylinder are photographed with a fast cinematograph camera whilst the engine is actually running. This method of studying rapidly moving explosion waves is similar to cinematographic methods of studying rapid motion in athletics, since the film, once it has been obtained, can be projected as a slow-motion picture. When the fuel/air mixture has been sparked, an explosion wave travels outwards from the spark plug. The front of the explosion is luminous and leaves a trace on the cinema film. The velocity of travel of the flame front can easily be calculated from measurements of the position of this trace in the engine cylinder, as photographed on successive portions of the cinema film. In normal cylinder explosions the observed velocity of travel is between 10 and 50 metres/sec. A cylinder of 10 cm. diameter would thus be crossed by the explosion wave between 1/100th and 1/500th sec. from the moment of sparking.

When the engine begins to knock the normal explosion wave is observed as usual, travelling outwards from the spark, but before the flame front reaches the remoter parts of the cylinder the remaining gas suddenly explodes almost instantaneously. The velocity of this knocking explosion is about 2000 metres/sec., and its duration about 1/30,000 sec. The very short duration of "knock" makes it similar to a minute charge of high explosive, and under extreme conditions knock can lead to considerable damage of the piston face.

In order to find out why this unwelcome behaviour is so closely connected with the chemical nature of the fuel, it is necessary to determine whether the flame front travels through the unchanged fuel/air mixture throughout the explosion, or whether any oxidation of the hydrocarbons has already taken place in any portion of the fuel before the flame arrives. Reliable evidence on this point is of great importance, owing to the fact that certain oxidation products of hydrocarbons, such as aldehydes, have a profound influence on combustion, and might alter the nature of the explosion if they were present in any quantity.

The role of oxidation products in the internal combustion engine has been investigated by analysis of samples of the contents of the cylinder, and also by adding various products to the hydrocarbons of the petrol, and noting their effect on knock and on the power developed. In the analysis, samples are collected during the actual running of the engine, by fitting a special valve opening for about 1/1000th sec. into the cylinder head. For an engine doing 600 rev./min., the compression stroke is completed in 1/5th sec., and the flame travel in about 1/100th sec. By timing the moment of opening of the special sampling valve it is possible to follow the chemistry of the fuel/air mixture even during these small fractions of a second.

The extent to which combustion of the fuel/air mixture has taken place before the arrival of the flame front can be related to any one of the following analytical results obtained from the samples:

(1) Proportion of oxygen consumed, and formation of carbon monoxide and dioxide in the engine cylinder.

(2) Proportion of formaldehyde and other aldehydes formed.

(3) Proportion of oxides of nitrogen formed (nitrous fumes).

(4) Proportion of organic peroxides formed.

All four analytical criteria yield the important result that the amount of oxidation products formed before the arrival of the flame front increases rapidly as the compression ratio is increased. The fact that certain of these oxidation products are responsible for the knocking explosion is suggested by the effect of adding lead tetraethyl. This suppresses knock, and simultaneously decreases the amount of oxidation products.

A direct proof of the chemical origin of knock has been achieved by adding each oxidation product in turn to the original

fuel, and noting whether or not the knock increased. The results are as follows:

(1) Formaldehyde does not knock, and an engine can even be run on pure formaldehyde vapour as fuel. Acetaldehyde does not lead to an increase in knock until the amount added to the original fuel is much larger than the amounts formed in the engine cylinder. Other aldehydes show a similar behaviour.

(2) Oxides of nitrogen, even when added in amounts larger than those formed in the engine cylinder, reduce knock.

(3) Organic peroxides, such as ethyl hydroperoxide or acetaldehyde peroxide, lead to violent knock even when the amounts correspond to as little as 5 parts in a million. Organic nitrites have a similar effect. It is found that these pro-knocks induce knock not only in poor quality fuels like long-chain paraffins, but also to a comparable extent in fuels like butyl alcohol, which do not knock when pure. The view held is that long-chain paraffins are poor fuels, with low H.U.C.R., merely because of their tendency to form traces of pro-knocks before the arrival of flame.

This unfortunate property of one of the major constituents of natural fuels can be overcome to some extent by a suitable engine design, so as to make the conditions less favourable for the formation of oxidation products before the arrival of the flame. One way of securing this is to fit two spark plugs to each engine cylinder. In this way each explosion wave has only to traverse half the distance of the cylinder head, and the time available for the formation of pro-knocks is halved. This arrangement of spark plugs is currently used in high-efficiency aero engines. Nevertheless, the main technical progress lies in the discovery of economic means of producing fuels with bunched molecules or aromatic hydrocarbons, and to a limited extent in the addition of anti-knocks to the fuel.

No practical application of the discovery of pro-knocks has as yet been made, partly on account of expense. They have the valuable property of facilitating the ignition of fuel oils, and may ultimately be applied in improving poor-quality Diesel engine fuels. On account of their remarkable property of leading to knock even in very small concentrations, they have been suggested for use in anti-aircraft defence. It would, however, be necessary to discharge a sufficient quantity of pro-knock vapour in the neighbourhood of the air intake of the aero engine to disable it; at present this is not practicable.

SUGGESTIONS FOR FURTHER READING

The Science of Petroleum. By A. E. DUNSTAN and others. (Four volumes.) Oxford University Press. 1938.

This contains a series of articles by experts on various aspects of the subject, and gives very complete references to original papers.

Particular reference may be made to the contents of vol. IV.

Other books on special topics are:

The Internal Combustion Engine. (Second Edition.) By D. R. PYE. Oxford University Press. 1937.

L'Inflammation et la Combustion Explosive en Milieu Gareux. By M. PRETTRE. 1934.

Combustion, Flames, and Explosions of Gases. By B. LEWIS and G. v. ELBE. Cambridge University Press. 1938.

Notes of the Month

THE SPLITTING OF URANIUM:

Can Atomic Energy be Harnessed?

THE discovery that uranium can be split into two large pieces (*Discovery*, Notes of the Month, April 1939) is still attracting the attention of a large number of scientists in nuclear physics laboratories all over the world. The developments in the study of this new process are proving scarcely less interesting than the original discovery.

From Paris comes the report of experiments by Joliot in which he finds that in the explosion of the uranium nucleus that is brought about by the bombardment with neutrons, these latter particles are themselves emitted.

This result is of great importance and, with a little imagination, one can easily regard this as the first real step towards the elusive goal of harnessing the vast store of nuclear energy which is released only very occasionally in processes so far investigated. If one neutron when hitting a uranium nucleus so as to cause an explosion, produces on the average *more* than one neutron amongst the products of the nuclear explosion, then, providing there is no large absorption of neutrons by other processes, the number of neutrons emerging from a block of uranium might quite reasonably be greater than the number that enter. In this way it might be possible to produce far more intense beams of neutrons than have ever before been possible, and each of these neutrons will have been produced in a process in which an enormous amount of energy has been released.

No definite details are yet available regarding the exact number of such secondary neutrons produced in each explosion. In addition the energies of the neutrons produced may be such that they do not give rise to as many explosions of uranium as the original neutrons. All these considerations represent problems for the future, and there can be little doubt that some interesting results will be found.

In Washington, U.S.A., experiments have shown that in the process of bombarding uranium with neutrons some intermediate product is formed which continues to emit secondary neutrons *after* the bombardment has been stopped. The phenomenon of delayed emission of radiation by substances bombarded with neutrons (and other particles) is no new discovery, this effect (artificial radioactivity) having been discovered by the Joliots in 1934. What is new in the present case is the *type* of delayed radiation. In virtually *all* previous cases the delayed radiation consisted of either positive or ordinary electrons together, sometimes, with very hard X-rays, or gamma-rays. In the present case, however, neutrons are emitted in addition to the more usual types of radiation. The exact origin of these delayed neutrons is not yet clear, and there is some possibility that some of the secondary neutrons observed by Joliot are produced in the same way as those found in Washington.

In addition to these more spectacular results interesting details of the process have been investigated in many laboratories in Europe and America. Pictures of the process have been obtained with the beautiful and universally useful method of the Wilson cloud chamber. Chemical tests have shown that quite a large number of elements, including caesium, rubidium, xenon, krypton, etc., are produced in the explosion process. There seems some evidence now that the disintegration of the uranium nucleus does not always occur

with the production of the same pair of resultant atoms. Of course a number of additional elements are produced by the further radiation of electrons by the elements which are formed as a direct result of the explosion, and the presence of all these additional productions (many of which radiate electrons and so transmute again into different elements) make it very difficult to interpret in detail the complex data of experiments in this field. However, there seems to be a large amount of experimental data already produced in connexion with the remarkable and fascinating new discovery, and it would be rash to forecast or underestimate their precise significance.

S. D.

(*F. Joliot, Paris*)
(*Roberts, Meyer, Wang, Washington, U.S.A.*)

ARTIFICIAL PREPARATION OF A MISSING ELEMENT

BETWEEN hydrogen and uranium there are ninety-two possible elements (counting hydrogen and uranium themselves); of these only *four* remain to be discovered. They are: element 43, which is predicted to be something like manganese molybdenum; element 61, a rare earth; element 87, a halogen; and element 89, an alkali. (All elements are designated by such *atomic numbers* which run from 1 in the case of hydrogen to 92 for uranium. The *atomic number* has a physical meaning; it is the number of resultant positive charges in the nucleus of an atom of any element.)

Element 43 has now been prepared. Its proportions are being studied, but are not yet known, since the first recognized specimen was made only a few weeks ago. This work is a triumph for American physics, since element 43 was produced in the cyclotron at Berkeley.

In the cyclotron, as described in *Discovery*, vol. I, p. 441, particles are accelerated to an energy of millions of volts. Segrè made deuterons and neutrons at these great energies and bombarded molybdenum atoms. Element 43 was the result.

(*Segrè, Berkeley, University of California, U.S.A.*)

THE "LIVING FOSSIL" FROM SOUTH AFRICA

FEW news-items of purely zoological interest receive as wide a publicity as that given to the recent discovery off the coast of South Africa of a fish believed to belong to the Coelacanthidae, a family that had been thought to have died out at the close of the Cretaceous, about fifty million years ago. There is something about a "living fossil" that catches the imagination of the public, though the zoologist is familiar with many examples of isolated species or families which represent the only survivors of a group whose fossil record shows it to have been much more abundant and flourishing in the past. *Sphenodon*, the "tuatara" of New Zealand, is perhaps the most familiar example; but many other groups such as the lung-fish, crinoids and brachiopods are to-day but shadows of their former greatness. There is no reason why the same should not be true of the Coelacanthidae, but it is interesting to find that such a conspicuous and remarkable species has hitherto escaped notice. The chief interest of the discovery lies in the light that it may be able to shed on the origin of higher vertebrates from fish.

The new species was caught last December near East London at a depth of 40 fathoms. Its large size (length 5 ft.;

Latimeria chalumnae, *the Coelacanthid recently trawled off the*

Latimeria chalumnae, *the Coelacanthid recently trawled off the African coast. The peculiarlyshaped tail with "axial supplement" can be seen; also the fins which, with the exception of the first dorsal, possess a median scaly lobe from which the rays arise.*

(*Nature*)

Undina, *a Coelacanthid common in the Jurassic of England and Germany. The fins and tail are very similar to those of* Latimeria. *The ossified swim-bladder is clearly visible.*

(*Zittel: Text Book of Palaeontology, Vol. II*)

weight 127 lb.), bright blue colour, and curious, somewhat archaic shape, must have made it a striking object when alive. Unfortunately, the resources of the East London Museum were inadequate for its preservation, and the viscera were thrown away before they could be examined by an expert. The skin, the skull, and a few other fragments of the skeleton is all that remains. It has been given the name of *Latimeria chalumnae*.

The most conspicuous difference between *Latimeria* and the majority of modern bony fish lies in the shape of the fins and tail; and it is precisely in these points, as may be seen from the illustrations, that it shows a striking resemblance to the later members of the Coelacanthidae, such as *Undina* and *Macropoma*. In the ornamentation of the scales and the arrangement of the bones of the head the agreement is equally marked. A remarkable feature of the fossil forms is the ossification of the air-bladder; whether this is found also in *Latimeria* is not yet known.

The Coelacanthidae are a comparatively specialized family, but the order to which they belong (Crossopterygii) includes certain forms from the Devonian which bear a closer resemblance than any other fish, living or extinct, to the primitive amphibians that appeared in the Carboniferous. From such primitive Crossopterygians there appear to have been four main lines of descent: (1) the Dipnoi, or lung-fish; (2) the first Amphibia, and through them all higher vertebrates; (3) the majority of modern bony fish; (4) the Coelacanthidae and related forms. It will be seen therefore that *Latimeria* is in no sense a "missing link"; but in so far as it has probably departed less from the structure of the common ancestor than have any of the other lines of descent, it may be expected to help our understanding of the evolution of the fishes and the origin of land vertebrates—and for this purpose one fresh specimen, even in a sadly mutilated state, is worth a hundred fossils.

The chances of catching further specimens are hard to estimate; it appears probable that the species is a deep-water one, and that only occasional stragglers reach the grounds that are normally trawled.

D. A. W.

(*Smith, Grahamstown*)

"EVAPOROGRAPHY"

FOR spectroscopists the photographic method of detecting radiant energy has two valuable advantages over all others:

(*a*) A wide range of wave-lengths may be investigated simultaneously.

(*b*) The effect of the interaction of the radiation and photographic material can be integrated over a considerable time.

In the infra-red, however, it is found that photographic plates can be used only as far as 2000 A. (or 1·2 μ), and since the most valuable region for research workers is beyond this, nearly all infra-red work has been carried out with non-integrating "one wave-length at a time" methods using thermocouples and other detectors of the non-selective type.

Recently, Czerny and his collaborators have been working on an integrating method which can be used as far out as 10 μ. They call the process evaporography.

Replacing the photographic plate there is a thin celluloid film about 0·1 μ thick, coated on one side with an absorbing medium and on the other by a very thin layer of a specially chosen paraffin. When the film is "exposed" paraffin distils from the region heated by intense radiation to cooler parts where the radiation is weaker. The resulting changes in thickness of the

paraffin layer can be made visible and are photographed by interference effects produced with monochromatic visible light. By pumping away the air surrounding the "plate" leaving only the vapour of the paraffin itself, evaporation of the latter is accelerated and exposure times greatly reduced.

In its present form the method is not very suitable for general application, but improvements will no doubt be made and its usefulness extended. L. L.

(*Czerny*)

THE DISCOVERY OF THE COFFINS AT TANIS

THE historical importance of the recent discovery at Tanis cannot be over-estimated. Little is known of the period to which it belongs, but the find will shed a flood of light into its obscure recesses. The two coffins of precious metal show that the wealth of the Pharaoh was very great, but it is as yet too early to learn whether the workmanship is as fine artistically as the objects found with Tut-ankh-Amen. The canopic jars are apparently of the late type with the heads of "living creatures" like those described in the Book of Revelation. The figures of deities should include that of the cat-goddess who was the local deity of Sheshank's chief city. A peculiarly interesting point is the find of two female skeletons, one on either side of the sarcophagus, in a position which suggests a human sacrifice.

The published accounts indicate that there is more than one royal tomb; it seems possible, then, that the excavator has come upon the family burial-place of the Pharaohs of the dynasty. If so, this would be indeed the greatest historical find of the century.

Though there have been tomb-robbers in Egypt ever since there were tombs in the Nile Valley, and though excavations, scientific and otherwise, have continued there for centuries, yet every now and then Egypt springs a surprise on the astonished world. The tomb of Tut-ankh-Amen showed the richness of a Pharaoh's equipment for life in the Hereafter. Immense wealth was to be expected at the time of Tut-ankh-Amen, for Egypt had been the mistress of the known world, and all the riches of the north and south had flowed in on her. But Egypt had steadily declined in power after that period; and when Saul founded and David consolidated a kingdom, Egypt had sunk into an inconspicuous little realm of which the records are few. A band of adventurers forced their way through southern Palestine, settled themselves in the Egyptian Delta, and—probably by marriage with the daughters of the effete Pharaohs—made themselves masters of Egypt and founded the XXIInd dynasty. The names of these Pharaohs show their foreign origin: Sheshank, the man of Shushan, Osorkon or Sargon, and Takeloth, who is Tiglath in Assyrian. The energy of the founder of the dynasty, Sheshank I, roused Egypt from the lethargy into which she had fallen. He held the coast road between Egypt and Palestine, where his fortresses have been recently excavated by Sir Flinders Petrie; he appears to have established a great trade in horses and chariots with foreign countries; he took by assault the fortified city of Gaza and gave it as a wedding present to his daughter when she married Solomon. Sheshank's daughter was obviously a matrimonial "catch", for Solomon did all in his power to please and gratify her. But on Solomon's death Rehoboam, his son by another and inferior wife, became King. The reason why Sheshank invaded Palestine was perhaps because he expected his daughter's child to succeed to the throne,

and the raid may well have been a punitive expedition. He reached Jerusalem and looted the temple of Jehovah. The amount of plunder can be estimated by the accounts of the building and furnishing of the temple as given in the books of Kings and Chronicles, "for the weight of gold that came to Solomon in one year was six hundred and threescore and six talents of gold, beside that which the chapmen and merchants brought". If the Tanis tomb is indeed that of Sheshank I, it is possible that some of the vessels of the ancient temple of Jehovah may be found there intact.

M. A. M.

(*Montet, Strasbourg*)

EARLIEST KNOWN EXAMPLE OF SYSTEMATIC ARCHITECTURE

PROFESSOR JOHN GARSTANG'S preliminary report on his excavations at Mersin in Cilicia during the past winter open up a vista of the early development of civilization in the Near East. At a level, the sixteenth, in the mound at Mersin, twenty feet below the imperial Hittite fortress uncovered by the expedition in its work last year, Professor Garstang has now found the remains of a brick-built fortification with water-gate, and dwellings underlying stratified series of building levels which by their painted pottery can be correlated with the early predynastic Mesopotamian cultures of Uruk and el Ubaid. The sixteenth level in which this fortress has been brought to light, like those immediately above it, belongs to the Chalcolithic or Copper Age; and it is indicated by the type of its painted pottery that it was in direct contact with the Mesopotamian culture of Tell Halaf, as it is termed, which preceded those of Uruk and el Ubaid. *These brick structures are, therefore, the earliest known examples of systematic architecture, and may be dated on a conservative estimate to about* 3600 B.C.

This, however, does not complete the remarkable tale of years. The sixteenth level lies less than half-way down the mound, and below it are some further forty feet of the deposits resulting from human occupation before plain level is reached. Of these earlier deposits it is known that ten feet at least still belong to the Chalcolithic period; but Mr Miles Burkitt of Cambridge, whose expert opinion has been invited, distinguishes in the underlying strata two phases of Neolithic civilization. Of these he places the beginnings of the more recent at not later than 5000 B.C., while the earlier, of which the lowest point yet reached is about the twelve-foot level, "must date to a thousand years earlier".

E. N. F.

(*Garstang, English expedition in Cilicia*)

SALT CURE FOR HAY FEVER

ONLY a victim of hay fever can know the extreme discomfort and enervation which accompany this disease. The report of any new method of treating it is therefore always received with great interest by sufferers. So far, very good results have been achieved in many cases by ionization of the nasal passages or by injections of pollen extract in order to make the patients insensitive to the pollen. Last year, a new and amazingly simple method was tried in Arizona, U.S.A. It consisted of the administration of small doses of simple salts of potassium, such as potassium chloride. Out of twenty-nine patients who were treated, twenty were practically completely relieved of their attacks and the remaining nine greatly benefited although some slight symptoms persisted. Often the relief began within a few minutes of taking the salt.

In one family where four individuals had hay fever, two were given the salt and improved at once; the two not treated continued to have hay fever. One boy, who had had hay fever for eight years, found great relief for a few years after annual courses of injections. Then, as his doctor was ill, he did not receive his injections last year: when the hay-fever season began (in autumn in Arizona), he was taken ill with an extremely severe attack. He had hay fever, asthma, vomiting and severe abdominal pains. In ten days, he lost fifteen pounds in weight. He was given a dose of potassium chloride, and within half an hour he stopped sneezing and vomiting and was able to breathe normally. By next day he was completely better and during the next week he gained ten pounds.

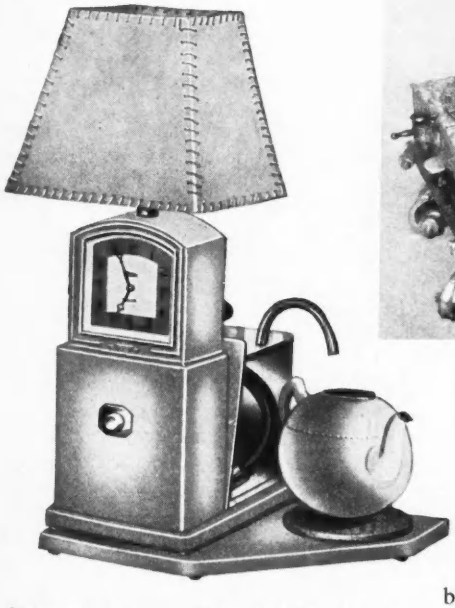
This treatment then seems to be remarkably effective. But a word of warning—the salt must be taken with great care, since slightly too much may cause severe abdominal pain and distress. This is definitely a treatment in which self-medication is to be avoided.

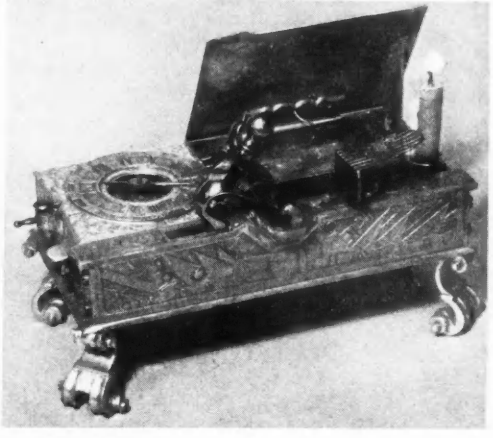
J. Y.

(*Bloom, Arizona*)

ALARM CLOCK-TINDER LIGHTER

AN unusual exhibit in the new Illumination Section at the Science Museum, South Kensington, opened in April, is a





tinder pistol automatically lighting a candle, and combined with an elaborated clock movement. This alarm clock-tinder lighter is inscribed "Joseph Tich, Wienn, Austria". It dates back to the eighteenth century. For comparison we have here added a picture of the latest electrical improvements on the self-same idea. At a time pre-set on the alarm clock the hedonist is wakened, his room is illuminated, and a pot of tea is made for him. All he has to do is to pour it out before it gets cold. Luxury is an ancient notion. There was once a Chinese Mandarin who was wakened three times every morning to be told it was not yet time to get up.

FLOWER PROBLEMS. I

(The study of flowers is one of the sciences open to the amateur, it needs a keen eye, a good memory, and little expensive equipment. Discoveries are constantly being made in the field, and there are a good many problems in which accurate observation and record can be of the greatest help. Here from time to time it is hoped that non-technical articles by botanists may appear, dealing with individual plants and the particular questions they raise. These articles will be written and illustrated with the intention of getting the help of readers of Discovery.)

A Flower Problem that readers may help to solve

The Butterbur

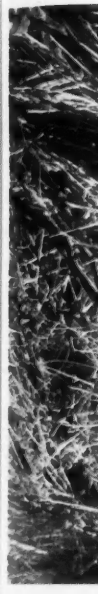
By Dr D. H. VALENTINE

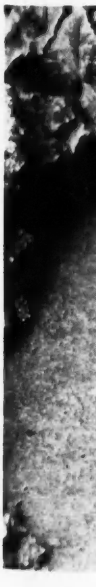
THE butterbur is a common plant over the greater part of the British Isles. It grows in marshy places, often by river banks; in the summer time, its large rhubarb-like leaves hide the surface of the ground from sight. The leaf stalks are often two or three feet long, and the leaf itself may be a foot or more in diameter.

The flowers come up in March, before the leaves. In late February, fat buds, about the size and shape of a hen's egg, appear at the surface of the ground; if they are dug out, it can be seen that they spring from a stout rootstock which runs horizontally in the soil an inch or so below the surface. The scales that cover the bud are soon forced apart, and the inflorescence, or flowering spike, appears, and eventually reaches a height of about six inches. Butterbur plants are gregarious, and in a favourable spot, fifty or a hundred of these inflorescences may be seen dotting the ground a few inches apart. There is usually little other vegetation in such places; the dense shade cast by the summer foliage is clearly unfavourable to the growth of other green plants, which must have light to thrive.

In most parts of England, the inflorescences are all of one kind (photograph I). Each *inflorescence* consists of a collection of stalked flowering heads, springing from an erect main axis. Each *flowering head* is composed of a mass of tiny flowers, enclosed in an involucre or envelope of strap-shaped bracts, their green often tinged with pink. Each *flower* has five minute rose-pink petals united at the base of the flower to form a tube, and from the mouth of this tube springs a blunt rod, the style, which sticks out beyond the petals, and is coated with grains of pollen. This pollen is produced by stamens which lie inside the tube, and is swept out by the style which elongates as the flower develops.

A normal flower, such as a buttercup, has both stamens producing pollen (male), and ovaries (female), that is, it is hermaphrodite. When pollen is transferred to the ovary it brings about fertilization, the result of which is the setting of seed. The butterbur flowers that we have described produce pollen and possess an ovary; they also have a style, which, in the normal flower, would be the organ which receives the pollen and conducts fertilizing elements to the ovary. In this butterbur flower, however, the style has lost its normal function, and is no longer sensitive to pollen. Its function is simply the exposure of pollen in a place where it is likely to become attached to visiting insects; the ovary is never fertilized, and the flowers are therefore functionally male. As all the flowers in the head and





D. II

II. Flowering heads of the female Butterbur plant, growing in the bank of a small rapidly flowing stream which runs into the River Irwell, at The Cliff, Salford, Lancs. The leaves have not yet appeared

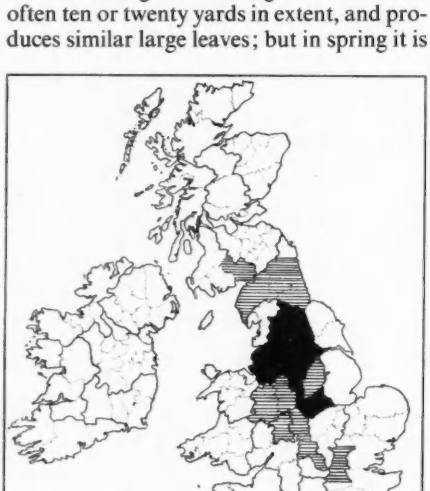
Photograph taken 1 *p.m. March* 21*st*, 1939, *on Agfa ISS, f* 22 $\frac{1}{4}$ *sec.*

I. Flowering heads of the male Butterbur plant, growing by the water side on a small island in the River Cam, at the base of a concrete bridge over the Fen Causeway, Cambridge. Both this year's leaves and the dead stalks of last year's leaves can be seen

Photograph taken 1.30 *p.m. March* 29*th*, 1939, *on Agfa Colour, f* 4·5 $\frac{1}{20}$*th sec.*

all the heads on the plant are of the same kind, it follows that these plants are functionally male. *It is a striking fact that in most parts of Great Britain, only male plants are found* (photograph I).

In the north of England, however (at Manchester, for example) we find *along with the male plants* a different kind of plant which is functionally female. In summer the female plant looks exactly like the male; it grows in large communities, often ten or twenty yards in extent, and produces similar large leaves; but in spring it is



Map showing distribution of female plant in England

quite distinct. The inflorescence is similar in shape and size to that of the male plant, although it is not so massive and the rosy pink colour is not nearly so marked (photograph II). The flower heads are approximately spherical (see fig. 1) not, as in the male, shaped like an inverted cone (see fig. 2), and the bracts of the involucre are shorter. The flowers themselves are of two kinds; in the centre of the head are two or three flowers of the kind we are already familiar with, that is, having five pink petals, but the style is short, and it is not covered with pollen grains. In fact the stamens of this flower, as well as the ovary, are abortive, and the flower is a neuter, and has as its only function the production of nectar, a function it shares with the true male flowers; there are only two or three of these neuter flowers in the female head.

The majority of the flowers are functionally female, with a well-developed ovary bearing a slender style, *forked at the tip* The inner surface of the fork is sensitive to pollen; but these flowers have neither stamens nor conspicuous petals, and look, in fact, like fine white threads—at the base of the "thread" is the ovary, at the tip the minute fork of the style. When these flowers are pollinated, the ovary develops into a seed.

In these mixed colonies the normal processes of sexual propagation are carried out. The flowers of the female plant are of two kinds, the one producing nectar, the other setting seed. The flowers of the male plant are all of one kind, and they produce pollen and nectar, but no seed. What probably happens is that insects, especially bees, visit both kinds of plant for nectar, and so transfer pollen from the male heads to the female. As a consequence, seed is set; the main stalk which bears the female flower heads elongates after pollination, often to a height of two or three feet, and in May one sees the tall stalks bearing heads of woolly seed. The seed is much like that of a dandelion, but about half the size, and it bears, like the dandelion, a tuft of hairs, called the pappus, which enables it to float in the wind. The seed is ready to germinate as soon as it has been released; but plants which are setting seed are not a common sight.

So far the story of the butterbur does not seem to be different in the main from that of many other plants; but there are certain facts about the distribution of male and female plants which raise an interesting but difficult problem. *The male plant occurs throughout the British Isles; the female plant is strictly localized* (see map). It is absent from Scotland, Ireland and Wales; and apart from a few scattered localities in the

valleys of the Thames and Colne and in Oxfordshire and in Warwickshire, it occurs only in the region between Leicestershire in the south and Dumfriesshire in the north. Even within this region, it is every-

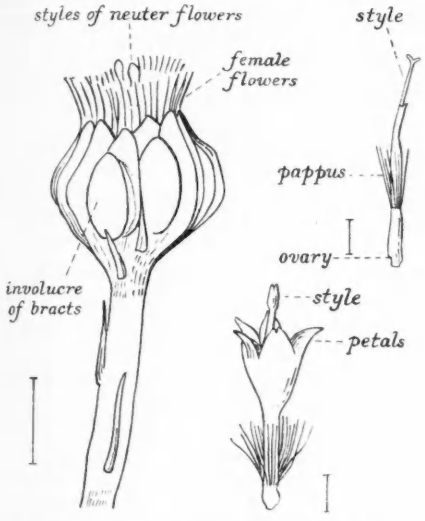


Figure 1. (*Left*) *head of flowers from female plant.* (*Right*) *single flower* (*female*) *from this head.* (*Centre*) *single flower* (*neuter*) *from the same head*

where rarer than the male, which is nearly always found with it, though usually in separate clumps.

This distribution presents the botanist with a problem which is "a most ingenious paradox". One expects male and female plants to be found together, as seed can only be produced when they are within striking distance of each other; and so, in certain districts, they are; *yet over large areas of country where the plant is common, there are no female plants and there is no seed production.* The question, how the male plant managed to spread over the whole of Great Britain and Ireland, at once arises. More than one explanation may be advanced. For example, it can be supposed that when this country was invaded by plants at the close of the last Ice Age, both male and female plants of butterbur were among the invaders, that they spread to all parts of the country, and that subsequently, owing (possibly) to the change in climate, the female plant has become extinct over most of its former range, while the male plant has been able to survive by purely vegetative multiplication. There is evidence enough that climatic changes of some magnitude have taken place since the

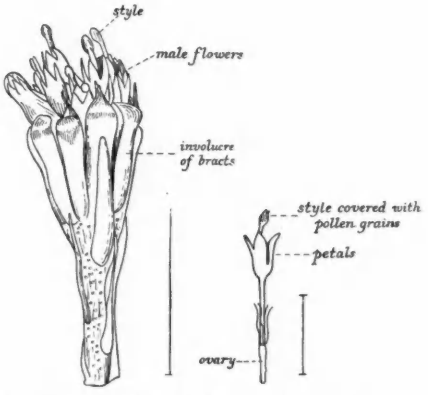


Figure 2. (*Left*) *head of flowers from male plant.* (*Right*) *single flower* (*male*) *from this head*
In both figures the actual size of the flowers is shown by the lines beside them

last Ice Age; but our hypothesis also involves the assumption that climate is a major factor in determining plant distribution. There can be no doubt that this assumption, is, in the broadest sense, justified, so that our hypothesis may be true, though as yet it has not been tested by reference to fossil remains. That the climatic factor is indeed involved is fairly certain, as the plant behaves in the same sort of way on the Continent as in Britain; the female plants are rare or absent in northern Europe, e.g. in Scandinavia, and the only kind of plant found is the male.

In many cases, of course, local factors such as type of soil have to be taken into consideration when studying plant distribution. In the case of the butterbur, we know as yet too little of these local factors to

be able to speak with any confidence about them. The amount of moisture in the soil is probably one of the most important local factors. It has been shown, in a locality in Germany, that where male and female plants are growing together, the female tends to occupy the wetter places. In a Lancashire locality it has been found that both male and female plants occur mainly where water is moving at or over the surface of the ground, e.g. where small springs emerge from a hillside, but that the male plants are perhaps able to colonize drier habitats than the females.

An alternative hypothesis to account for the present wide distribution of the male is that it has been gathered and planted by man, as a plant producing early nectar for bees, and that once thus established, it has been able to spread vegetatively. There is some evidence, in the older Floras, that there has been some planting of this kind; as regards vegetative spread, the rootstock is very powerful and can penetrate the soil to a distance of many feet. This is undoubtedly one of the means by which the plant invades fresh ground; pieces of rootstock can also be carried by streams, probably for long distances. How far this method of spread is effective when barriers such as arms of the sea and ranges of hills are encountered we do not know, but in such cases it is hardly likely to be of use.

Whatever may be the past causes responsible for the peculiar distribution of the sexes of the butterbur, this distribution is now relatively stable; and it is to present conditions of climate and local environment that we must look for an explanation. Unfortunately, we know too little as yet about the habitats of the plant, and the details of the distribution of the female are still uncertain. For example, it is supposed to be absent from Scotland, Ireland and Wales, because the records speak of butterbur without specifying the sex, or say that the male only occurs, and because the few specimens that we have seen are all male. The writer would be most grateful for any information about the plants, especially with regard to localities for the female plant and the kind of place in which it grows. If any readers of *Discovery* are willing to contribute their actual observations, these may be of material help in settling the problem. But since, if observations are to be used there must be some evidence of their accuracy, anyone recording female butterbur should take the precaution either of sending one of the small flowering heads from the inflorescence, or one of the fruiting heads, with his record. Letters may be addressed to the author, Dr D. H. Valentine, c/o *Discovery*, University Press, Cambridge.

Letters from Readers

The Unusual Habitat of Wild Flowers

THERE appeared in your correspondence columns recently some notes on the curious appearance in this country of *Lathraea clandestina*. I saw it growing apparently wild in Sussex, and in the December 1938 number another reader writes that he has seen it in Devon. What is the explanation of this and other cases of plants already belonging to our Flora establishing themselves far from their known localities?

The Sea Holly (*Eryngium maritimum*), a fairly common seaside plant, has a much rarer inland relative (*E. campestre*), which was practically confined to the west of England until recently when it appeared in Hants and since has become well established.

The Blue Salvia (*Salvia pratensis*), shown in the photograph, is supposed to be restricted in this country to a small area in east Kent, yet it turned up suddenly on the South Downs at Saddlescombe in Sussex and has established itself there.

Another plant which has appeared in a fresh locality recently is the Acrid Lobelia (*Lobelia urens*)—formerly this was only known near Axminster in Devon, then it appeared in Hants and has established one strong colony there.

Probably only a botanist would notice the tiny white-flowered Illecebrum (*I. verticillatum*), for it is very inconspicuous; until a few years ago it had only been found in the west of England, but recently it appeared in the New Forest and now grows in several places there.

Is the explanation, particularly in the case of these western plants, that a change in our climate, more mild or more suitable, enables them to extend their range by the normal process of seed dispersal and establish themselves where formerly they were unable to grow?

LANCE DAYL, Romsey, Hants.

"Mr Tompkins": Another Query

I HAVE found Mr Tompkins' dreams most interesting and illuminating; but there is one set of figures I should be glad to have some light on. At the top of p. 438 in the December issue we read that in one second the radius of the Universe increases by ten million miles. It is in italics for emphasis. If so, something, some material thing, must move at this prodigious speed. Has then the idea, a pillar I have understood of Einstein's Theory of Relativity, that nothing can exceed the speed of light, been given up?

P. F. FYSON, Hooe, Plymouth.

(*This letter was sent to Professor G. Gamow, of Washington University, whose explanation is given below.*)

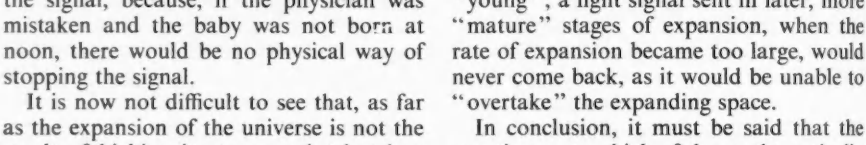
APPARENTLY some readers have been surprised about the sentence in Dream I that "the radius of the universe increases by ten million miles each second", as this value is evidently considerably larger than the velocity of light. It should be noticed, however, that the proposition of the special theory of relativity that "no velocity can exceed the velocity of light" refers only to the motion of material bodies, or waves which can be considered as carrying a signal from one point to another, and is not, in general, applicable to "prearranged" types of motion. The following example will, perhaps, clarify the matter.

In ancient Turkey it was customary to announce the birth of the heir to the Sultan by waving a flag from the roof of the palace. The soldiers were installed between the capital and other cities so that they could see each other, and each of them waved his flag when he saw another do so. Thus, supposing that the reactions of the soldiers were fast enough, one might say that the signal announcing the birth of the heir was propagated from the capital with the velocity of light. Suppose now that the Sultan's physician were to predict that the

baby would be born exactly at noon, and the court officials wanted to give the impression that the signal was propagated twice as fast as light can carry it, knowing the time of birth in advance they would send on officers along the signal-lines with instructions to the soldiers to wave their flags, not on seeing the previous man do so, but at definite prearranged times. The time points at which they should wave their flags can now be arranged in such a way that the flag at a certain distance from the capital will be raised when the signal starting from there at noon is still only half-way on its journey: a stranger on the highway will thus observe the wave of rising flags being propagated with a velocity twice as large as that of light.

But it is easy to see that such a wave does not actually represent the propagation of the signal, because, if the physician was mistaken and the baby was not born at noon, there would be no physical way of stopping the signal.

It is now not difficult to see that, as far as the expansion of the universe is not the result of kicking it at one point but is a prearranged motion of all material bodies in space, there is no contradiction in saying that its radius or its equator increases at a rate larger than 186,000 miles per second.



Besides, such a "rate of increase" of the equator of the universe does not necessarily represent a definite velocity of a material body: The length of the world's equator can be defined, for example, as the distance from the end of somebody's nose to the back of his head measured round the universe, which, however, does not mean that (even if the head is expanding with the rest of the universe) the relative velocity of these two points is many million miles per second!

In different cosmological models, following from the general theory of relativity, the behaviour of radius with time is rather different. There is a model, for example (the so-called "hyperbolic universe with positive cosmological constant"), which is unlimitedly expanding, the rate of the expansion tending to infinity, as the expan-

sion proceeds. In such a universe the light signal can travel round the world only if it was sent when the universe was sufficiently "young"; a light signal sent in later, more "mature" stages of expansion, when the rate of expansion became too large, would never come back, as it would be unable to "overtake" the expanding space.

In conclusion, it must be said that the question as to which of the mathematically possible cosmological modes represents the actual physical space is, at present, far from being definitely solved, and that the number given to Mr Tompkins by the Professor should only be considered as giving an idea of the immense scale at which the expansion of the actual universe is taking place.

G. GAMOW, George Washington University, U.S.A.

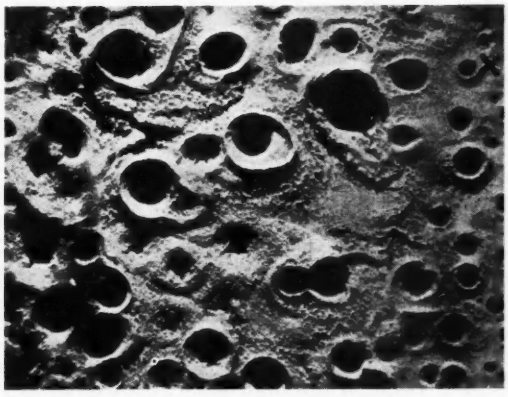
In Dream I, owing to a misprint in the original manuscript, a correction should be made: On p. 437, *third line from below instead of "several millions of light years" one should read "several hundred millions of light years".*

Lunar Craters

MY article, "The Problem of the Lunar Craters" published in the July 1938 issue of *Discovery*, brought me a large amount of correspondence from all over the world.

Many of the discussions begun by these correspondents have been most stimulating and helpful. Some have noted similar effects in materials other than the surface of welded steel or those discussed in the article in question.

Amongst the most interesting was a letter and photograph from Professor J. Norman Collie, F.R.S., of University College, London. The photograph is reproduced here.



In his letter he writes: "It reminded me of an experiment I made over thirty years ago that might have a bearing on the problem. I had dissolved some sodium in alcohol to make the compound of the two (sodium ethylate, a solid). This was done in a large glass balloon. In order to get rid of the excess of alcohol the balloon was heated on a water bath, and nearly all of the alcohol was distilled off. The remaining pasty solid had still some alcohol mixed with it, so in order to get rid of this, the pressure in the balloon was lowered by connecting it with a vacuum pump. The result was that the surface of the pasty sodium ethylate got slightly cooled, and the hot alcohol below came bubbling up to the surface, making a series of craters similar to those on the moon. In fact they were so like the moon craters that I took a photograph of them.... Might it not be that when the moon was cooling and in a pasty condition, gases from the hotter interior bubbling up through the cooler outside surface produced the craters?"

C. G. JAMES, Woolston, Southampton.

The Water Level of Lake Victoria

IT has been shown that the water level of Lake Victoria in Central Africa rises and falls in agreement with sunspot periods. This appears to be due to variations in the Indian monsoon, which are in turn due to the air pressure variations over the Central Asian Plateau.

Unfortunately the daily Meteorological Chart of Weather in the Northern Hemisphere issued by the Meteorological Office does not show the isobars for this region. The daily chart does show the pressure conditions over practically the whole of the North American Continent and it would be a great aid to meteorologists to be as well informed concerning the Asiatic Continent. I thought this to be of interest to readers of *Discovery*.

R. M. DEELEY, Isleworth, Middlesex.

(The second article in the new series "Invitations to Knowledge" appears on the next page. As announced in our Editorial last month, this series is devoted to the presentation of simple scientific topics for our younger readers, whose interest we hope to stimulate.)

The Weather

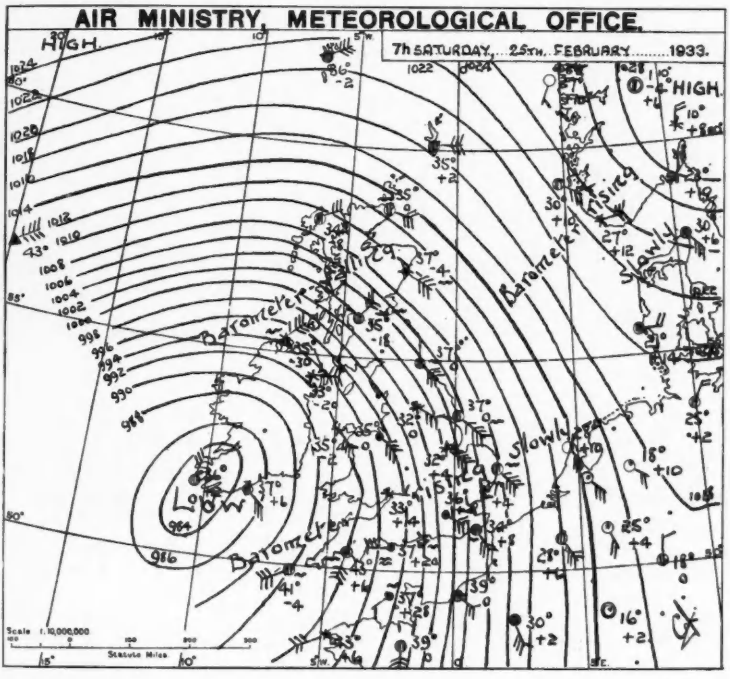
By COLIN ECCLESHARE

"WHAT is the weather going to be?" That question is one we often ask, and it has been asked by all sorts of people for many hundreds of years, for the weather is of very great importance, to travellers, by air or sea, to farmers, to builders, and to people like you and me, who only want to know whether to leave our raincoats behind or not. But before you can tell what the weather *will* be, you have to know what it is now, what it has been, and what makes it. The science which deals with these things is called Meteorology.

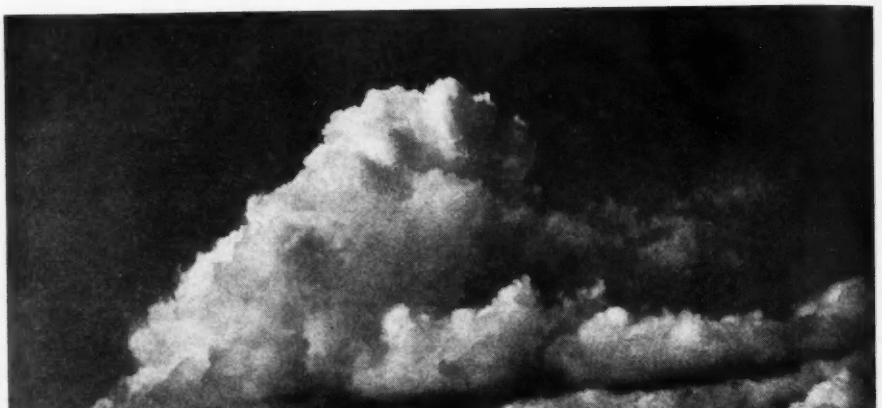
We usually think of man as an animal living on the surface of the earth, but it is just as correct to see him as a sort of deep-sea fish at the bottom of that invisible coating of air, called the atmosphere, which covers the earth like an ocean. It is what goes on in this invisible sea, the changes in temperature, pressure, moisture content, all the sort of changes we study in a Physics laboratory, that we call weather. Living, as we do, at the bottom of the atmosphere, we really do not know much about changes at higher levels, though these are probably very important in deciding the sort of weather we get; we can find out a little by sending up balloons with recording instruments, and occasionally specially built aeroplanes, or balloonists like Professor Piccard succeed in getting first-hand information. But with the aid of instruments, barometers, thermometers, wind-gauges and so on, we can find out something; and if we use our eyes and the B.B.C. weather forecast we can learn a lot more about weather.

One of the most important instruments for the meteorologist is the barometer.

This records changes in the pressure of the atmosphere, but it has to be used carefully. The ordinary household barometer which reads "Set Fair" when the pressure is high, and "Stormy" when it is low, is only a very rough indicator. What matters is not the actual reading of one barometer at any given moment, but changes—whether it is rising or falling, and how quickly—and also the relationship of one reading to others taken at different places. One barometer will tell us the sequence of pressure at one place, but to see what causes that sequence we have to look at a pressure map built up from readings at a large number of stations. The pressure map is the basis of the weather map issued by the Meteorological Office and published in the newspapers, on which isobars, lines joining places with the same pressure, are drawn. Words like depression and anticyclone, which are always turning up in weather reports, refer to pressure conditions, which are shown by the shapes isobars take; a depression is what you would expect it to be, a place where pressure is lower than in the surrounding areas, and it appears on the map as a series of isobars in closed rings, with the lowest in the middle; an anticyclone is just the opposite. In a depression winds tend to blow towards the centre of low pressure, or around it in an anticlockwise direction. In an anticyclone they blow outwards and clockwise. There are other shapes too, which you can learn to recognize later, but in this part of the world



Part of the daily weather map issued by the meteorological office showing a depression approaching the British Isles



1. *Cumulus. A heap cloud with a horizontal base*

2. *Cirrus. A high feathery cloud formed of ice crystals*

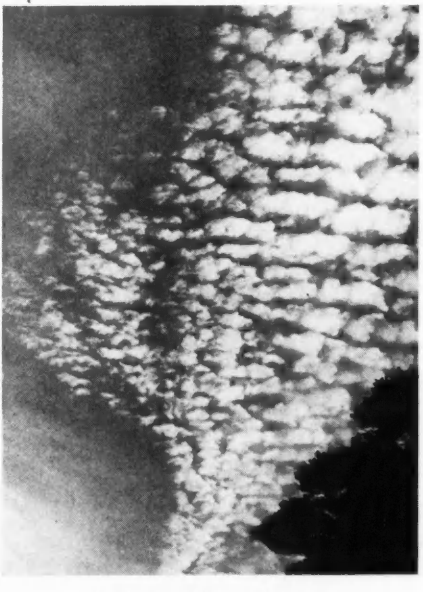
depressions are the important ones from the point of view of the weather we get, and if you look at the daily weather maps over a long period you will find that British weather really consists of a series of depressions, big and little, following one another in a general west to east direction. Some of these can be traced beginning as far away as America, crossing the Atlantic like eddies in a stream, deepening, and then growing shallower and fainter as they sweep across the British Isles and north-west Europe. It is these depressions which bring us our weather, and British weather moves with the depressions, generally from west to east.

But though you can see depressions on the pressure map, or watch the dips and bumps in the barometer readings, you cannot see a depression out of the window. You can, with a little practice, recognize the sequence of weather which goes with it. You can see the clouds, you can feel the changes from warm muggy air to cold fresh breezes, you can watch the rain. Gradually meteorologists have learned that these changes take place in cycles, with a general regularity, though no two cycles are exactly alike.

But before describing the sort of weather a depression brings, we ought to say a few words about clouds. Learning to recognize clouds is a difficult job, but one or two types can be picked out fairly easily. There are two main sorts of cloud, heap clouds and layer clouds. The best known of the heap clouds is called cumulus and is the towering, woolly, cabbage-shaped cloud shown in Fig. 1. It has a level base, but the top may pile up to very great heights and develop into the sort of thunder cloud shown in Fig. 3. The highest cloud is cirrus, which is a layer cloud formed of ice crystals; it generally has a wispy, feathery appearance. Another layer cloud, this time a low dark one, is called nimbo-stratus, which often brings rain.

As a depression moves over, the clouds and weather move with it, and any one place in its path experiences a certain sequence of

3. *This sort of cloud often brings thunder*



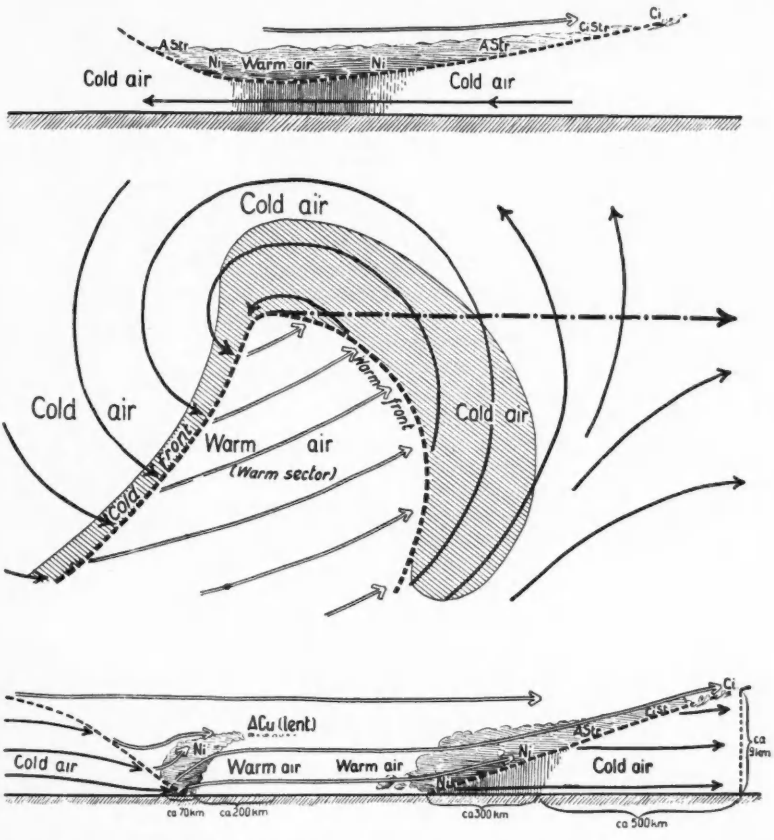
4. *Another form of cirrus*

"*Thin wispy cirrus cloud*"

Why does all this happen? Why does this stream of depressions flow across the North Atlantic? We know what a depression looks like on the pressure map; we know the sort of weather it brings, but what causes all these things? It is now generally believed that depressions are due to the meeting of two great streams of air. One stream consists of warm, moist air, moving northwards from the tropical areas, and deflected to the east by the rotation of the earth. The other is composed of cold air accumulated round the pole. Where they meet, in a belt called the polar front, disturbances take place. The warm tropical air, being less dense, rises over the cold heavy polar air, or, on the other hand, the cold air undercuts the tropical air. As the moist tropical air rises it is cooled, the water vapour it contains condenses, clouds are formed, and rain may ultimately fall. This is weather conditions. As the depression approaches, the weather may be fine, with thin wispy clouds. Gradually lower cloud appears, the sky becomes overcast, the air grows muggy and the wind becomes gusty; finally ragged nimbo-stratus covers the sky and rain falls. Then, often quite suddenly, the rain stops, the sky lightens, blue patches appear, the air is cooler and fresh breezes spring up. The depression is past. This sequence may take anything from a day to several days, and there are great variations. But that is the general scheme.

"*Lower cloud appears*"

"*Low cloud covers the sky and rain falls*"



The structure of a depression. In the middle a ground plan. On the right the warm air rises over the cold air, along the warm front*; on the left the cold air undercuts the warm air, forming a* cold front. *The area of rain is shaded. Above is a vertical section north of the centre, and below a similar section south of it. Clouds are shown by shading and rain by vertical ruling. The movement of the air is shown by continuous arrows*

the sort of thing which goes on in a depression, which is really an eddy in the air at the polar front. The diagram above shows the sort of structure a depression has, seen from the side and in plan. By the time depressions reach Britain this neat arrangement of warm and cold fronts may have become very complicated, as you will see when you come to look at the weather maps, but gradually experts are learning the way weather behaves and can make fairly accurate guesses at what is likely to happen for short periods ahead. Just how tricky the whole business of studying the weather is you can learn for yourself. The Meteorological Office publishes a great many booklets on the weather and the weather map, which can be bought quite cheaply; you can have the weather map sent to you daily, and Sir Napier Shaw's

Nimbo-stratus. A low dark cloud which often brings rain

Lightning

Cumulus clouds with a layer of cirrus behind

The Drama of Weather,* from which these diagrams are taken, deals with the whole subject in much greater detail than we have been able to here.

We have not said anything at all about thunder and lightning, cloudbursts, or similar more exciting forms of weather. Each of these could make a separate article. As a rule these more striking phenomena are due to local disturbances of the normal atmospheric conditions. Lightning, for example, seems to be connected with local areas of rapidly rising air currents, which are often revealed by the towering clouds, sometimes anvil-shaped, which develop before thunderstorms. These rising currents prevent the raindrops from falling, which is why thunder rain when it does fall is often sudden and heavy. As they are carried upwards the drops break up and become charged with electricity which is finally discharged as lightning to earth or other clouds.

* *The Drama of Weather*, by Sir Napier Shaw. Revised and enlarged edition. Cambridge University Press. 10*s*. 6*d*.

Reviews

Domesday Up-to-Date

THE inevitable momentary thought after running through the contents of the first volume of the *Victoria County History of Cambridgeshire and the Isle of Ely** is that the worms, the centipedes, the midges, the beetles, the bees and wasps and ants, the butterflies, spiders, snails, fishes, frogs, birds, and rats, here so cautiously identified and dated, do not recognize the county boundary imposed upon them. Certainly the experts to whom these various creatures and their families have been allotted are themselves aware of, and perhaps uncomfortable under, this artificial limitation. Their sections are admirably fair and complete records of what has been found in Cambridgeshire, but one and all admit that what has been found is no safe definition, for the obvious reasons (*a*) that it might have come into the county by chance, and (*b*) that something not on the list may very well be found to-morrow. One cannot help wishing that some all-knowing and understanding zoologist had been asked to sum up all these sections at last, and to give the complete picture of the faunal character of the county, describing in general terms the life that goes on in the place, year in, year out, and relating it as far as possible to the geology, the climate, the vegetation, and the human modifications of the place. It would have been a stupendously difficult task, and the editor of the volume has every right to reply that his job was to provide the material for such a survey, leaving it to his readers to construct (if they can) the natural general character of the county.

The Geology and Botany sections do not suffer nearly so severely from the artificial nature of a county boundary. Obviously enough, this is partly because rocks, soils, and plants are not migratory: it is possible to give good reasons why, from the character of the county, certain plants are to be found and where, or to show how the character of the county as a whole grows out of its geological structure. Each of these sections also has the advantage of a wider range of material brought under the co-ordinating power of one mind. The Botany section is given the unity of a story because the author has chosen the ecological point of view—which is nothing more than to say that he has approached his plants as natives of the county for their own discoverable reasons, or in his own words, he has chosen the ecological approach because this "shows the plant in close relation to its habitat, to factors of soil and climate, and human activity". It is true that Cambridgeshire is particularly suited to such treatment, because it is divisible into areas of well-marked character, and includes some places—e.g. the Fens—unlike anything else in England, and some parts of the Fens preserved as nearly as possible in a state of nature. But the botanical section, with all these inherent advantages, still shows the additional merit of a personal point of view, and is a model of how one may rationally set about the study of a limited area.

The archaeological sections begin the relation to human time and history proper; though here again one is conscious of the undoubtedly misleading effects of chance. You cannot excavate a whole county: discoveries of relics of vanished races are generally dependent upon chance in the first place; and in archaeology particularly there are tantalizing records of inexpert unearthings, recorded only by rumour, and no longer capable of verification. Of early man the material at present available is too scattered to permit the author of this section to give any connected story, though there are many beautiful isolated finds which suggest that a story remains to be discovered. In 1844 a man exercising the right of the poor to dig peat in Grunty Fen, "after digging three feet through the peat came upon three very perfect bronze celts lying close to each other.... Twelve inches below, and rebounding with a spring that threw up to the surprise of the labourer a portion of the soil, appeared a gold ornament —the famous multiple-ribbon torc with solid tapering terminals, a splendid object of pure gold weighing 5 oz. 7·20 dwt. and 47½ inches in overall length". Enough is known of the find for it to be safely said that the torc was buried intentionally, "though whether as a cache to be recovered in the future or as a votive offering must remain a matter of opinion". Several such hoards of metal objects have also been found, some of them the stores of traders, others collections of scrap metal made by metal workers. Altogether, a surprising variety of metal objects, weapons, personal ornaments, and household ornaments, show that Cambridgeshire was populous even in prehistoric times.

The Anglo-Saxon remains of Cambridgeshire are even richer. Mr Lethbridge's account of them is one of the most interesting parts of this first volume. A number of large burial grounds have been found and excavated, notably one at Barrington "discovered in 1879 by the coprolite diggers by whom a large portion of it was destroyed. In 1880 114 graves were opened by archaeologists and their finds

* *A History of Cambridgeshire and the Isle of Ely*. Vol I, The Victoria History of the Counties of England. Oxford. 63*s*.

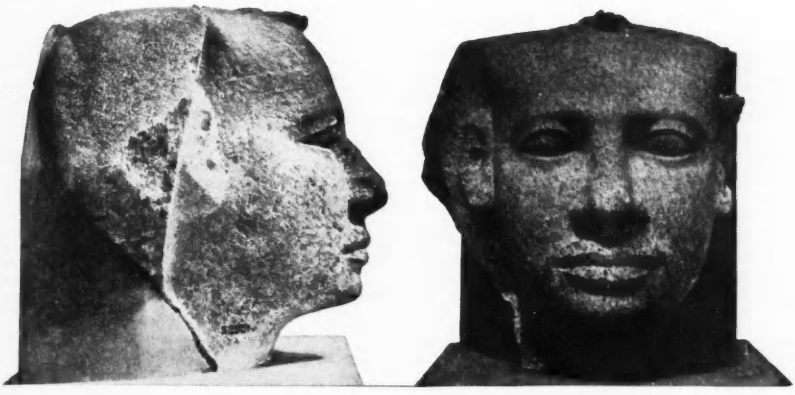
reported." Archaeology has no room for sentiment, yet a reviewer may be permitted a little irrelevant wonder at the methodical way in which treasures, once pathetically buried as tokens of man's common regret in the presence of death, are dug from graves by modern hands, cleaned, classified, exulted in, as evidence, not of grief, but of past history. Thus, from Barrington: "25 graves yielded 55 brooches in all. There were 12 pairs of wrist-clasps, girdle-hangers, bracelets, buckles." Tears for many graves, no doubt; but tears are not archaeology. Important cemeteries were also found during excavations at St John's College cricket field, and at the entrance to Girton College. Archaeology owes much to man's incurable awe of mere death.

This volume concludes with a full investigation of Domesday Cambridgeshire, and thus just gets into written history. Space now forbids more than a mention of this section. It is notable that almost all of the names of townships have survived to this day and are still identified on a twentieth-century map. Only five Domesday names have vanished.

The long-awaited first volume reads the unrecorded and almost dateless history of the county from the rocks, guesses a little at the movements of animal and vegetable history, and records for what they are worth the recent occurrences of all the known varieties of creatures: it deduces what-may-have-been from the rare and single relics left by early races, and closes with a minute examination and a complete translation of the first written records of the place. It is a new Domesday book of the district; but not prepared, like the old one, for any specific, materially useful purpose; a record, rather, that aims at being impartial, prepared on the off-chance that the future will want to know what it is able to set down; a noble and patiently worked out enterprise with no beginning and no end.

T. TWYNER

SHORTER REVIEWS



The Making of Egypt

OUT of the ripe experience of seventy-five years and more as an archaeologist, of which the greater part has been devoted to Egypt, Sir Flinders Petrie reviews* the civilization of the Nile Valley from the earliest times down to its close as an independent entity with the Ptolemies. He thus covers five great prehistoric periods, beginning with the recently discovered Tasian, and thirty dynasties, taking into account a range of some seven thousand years at the least. This is the longest period of cultural history known to us; and consequently it is of outstanding importance for the study of the actions and reactions of man as founder and member of an organized community.

To attempt to comprise so vast a field within the modest compass of less than two hundred pages is an ambitious project, which for anyone but an authority of the standing of Sir Flinders would seem foredoomed to failure. Here, however, the author is in pursuit of a special enquiry. At certain points in the history of the Nile Valley the Egyptian civilization is seen to take a fresh impetus, usually after a period of decadence, and expands to greater achievement than before. At other points for periods more or less prolonged the course of events is veiled

* *The Making of Egypt*, by Flinders Petrie. The Sheldon Press, 12*s.* 6*d.* net.

in obscurity. Taking it as axiomatic that the character of the civilization reflects the character and composition of the people, Sir Flinders endeavours to account for these vagaries in historic succession by analysing the evidence of the archaeological material, or the ethnic character of the population, thereby isolating elements which point to the influx of new blood from outside or the rise and decline of a fashion or a cult.

So many of Sir Flinders Petrie's innumerable discoveries as a pioneer in Egyptian archaeology have proved of signal importance in unravelling the knots in the history of the people of Egypt, and are now so frequently accepted as matters almost of common knowledge, that it is difficult to preserve a sense of perspective in indicating points of outstanding interest or importance with which he deals in his latest book. The discovery of the predynastic civilizations, the establishment of Menes, the founder of dynastic Egypt, as more than a shadowy mythical figure, the appraisement of the character and achievement of Khufu of the Fourth Dynasty, these, important as they may be, are only the merest sample of his contributions to knowledge of early Egypt; and equally throughout the long chronicle of the dynasties, of which the more difficult problems are here discussed, Sir Flinders has illuminated innumerable dark places by his discoveries.

In 1926, when the harsh provisions of the new Egyptian Antiquities Law constrained Sir Flinders to give up his work in Egypt, it might have seemed, even had he been a younger man, that a period had been put to his activity. In southern Palestine, however, he found a field in which his work of excavation has proved of no lesser service to Egypt. Among other matters it has elucidated in a considerable degree one of the most obscure problems in Egyptian history, that of the Hyksos, who overran Egypt in the period between the XIIth dynasty and the revival of Egypt which culminated in the New Empire. Here his discoveries have done much to unravel the character of the Hyksos domination and by showing that their dynasties were not all successive, but that some were contemporary, he has solved a chronological puzzle which previously had seemed without hope of solution.

The volume is fully illustrated, the objects figured having been selected with a care that enables the least instructed of readers to follow the argument.

E. N. FALLAIZE

The Evolution of Genetic Systems

DURING the last thirty years a new branch of science has come into being; it is called genetics. The object of genetics is to study the manner of transmission of traits from parents to offspring, and to determine the laws of the mechanism on which this hereditary transmission is based. Its implications reach far into our everyday life. We see already how the discoveries of genetics are utilized in the breeding of plants and animals, and the time may not be far off when eugenics, or that branch of genetics which concerns itself with man, will force its inevitable consequences upon mankind and perhaps cause a fundamental change in our present views concerning every aspect of life.

In view of its far-reaching importance it is natural that nowadays attention is becoming increasingly focused upon genetical problems. It is well recognized that the progressive evolution of a species or race rests upon heredity, variability and selection. Heredity perpetuates existing racial characteristics, variability provides for the occurrence of new types, and selection establishes the new types to form new groups. These processes of evolution are interrelated and form a closed system. In nature a great array of genetic systems are in operation, which in turn are themselves the product of evolution.

The present work* is a very successful attempt to show how these systems have evolved, how closely they are related to each other, and what is their role in evolution. If the reader already possesses some knowledge of biology, he will gain an insight into the apparently complex but admirably co-ordinated processes of evolution. He will learn that the unit or atom of genetics is *the gene*, the material basis of every characteristic, and that these genes are arranged in linear order to form the heritable substance within the cell—the so-called chromosomes. The reader will discover that the flexibility of a species in its ability to adapt itself to ever-changing environmental conditions depends upon the recombination of genes. One of the most profoundly significant mechanisms ever invented by Nature is crossing-over, or a partial exchange of hereditary material between the chromosomes. It is by this process that evolution proceeds, for new and, from an evolutionary point of view, important constellations of characters are brought about by crossing-over. A diagram in colour admirably illustrates the mechanism of crossing-over.

The chromosome theory of heredity is always in the foreground; the author never fails to emphasize that all phenomena of heredity are directly or indirectly influenced by the chromosome mechanism. The chapter dealing with chromosome mechanism not only describes chromosome structure but analyses the forces responsible for their movements. In another chapter it is shown that the chromosomes, which carry the genes, are themselves under the control of these genes. The adaptation and

* *The Evolution of Genetic Systems*, by C. D. Darlington. C.U.P. 10*s*. 6*d*.

evolution of the genetic systems have been possible through this mutual subjection. The apparently complex relationship between the processes of mutation, variation, adaptation and selection is shown to be understandable through the chromosome mechanism. The reader will realize that the chromosome theory is not an abstract "profession of faith"—it is an instrument of discovery.

The twenty-one chapters of the book touch upon practically every biological phenomenon, and the reader can view biology as a whole, and can see that its processes are always connected and interrelated. Every chapter opens up a new vista of the field of biology. It is hoped that the book will serve its purpose and bring to the reader the essential facts of evolution. The author has done a great service by presenting an objective synthesis of the phenomena of heredity from quite a new point of view. This should be felt more keenly now, when we witness the disastrous effects of false deduction or wrong application of genetic principles, in order to justify racial politics.

P. C. KOLLER

History of Science Heavyweights

FACED with two such heavyweights as these,* one turns naturally first to the book produced by the British author. It claims to be a history of science, not of physics or chemistry only, yet one notices at once a striking disproportion in the amount of space devoted to the different sciences. Physics and chemistry receive 380 pages and biology only 72, which would be increased to but 150 if we were to include the social sciences such as economics in with biology. Technique (applied physics and chemistry) gets another 170. This will hardly balance the accounts of the eighteenth century, the period of Buffon and Linnaeus, of Trembley, Spallanzani and Hales.

However, it is needless to say that the book contains a vast mass of information. Canals and cryptogams, rain-gauges and rolling-mills, atoms and air balloons; all kinds of particulars will be found to satisfy the curiosity of readers. Unfortunately, they will hardly do more, for Professor Wolf expressly disclaims in his preface the intention of doing anything to set science in its proper social and economic background. Even his discussion of economic theories seems to be divorced from any historical setting. But such criticisms would not matter if the book could be regarded as an indispensable work of reference, bibliographically reliable. A position of this kind, however, cannot well be granted to it, for although the text contains a considerable number of more or less uniformly cited references, not a single one of the illustrations is identifiable. Portraits are labelled just "Buffon" or "Cavendish". Otherwise admirable plates are labelled "Gralath's Experiment" or "Lyonet's Illustrations of Caterpillars". Such an unscholarly procedure, which will make the book the despair of other workers in the field, cannot be too strongly condemned. We note that the dust cover carries a wreath of plaudits from eminent scientific pundits, but no congratulations from a historian, even of science.

The second book, though far less ambitious, achieves its aim better. Chemistry and chemical apparatus are exhaustively described and pictured, from the ancient Egyptians to Liebig's famous laboratory at Giessen at the beginning of the nineteenth century. It will come as a surprise to some to see how elegantly the elaboratory of Andrew Libavius was arranged in 1606. The book can be recommended, but one cannot approve of the total omission of the translator's name; and the frontispiece, which is labelled "First picture of a balance with stops for the pans, (T. Leupold, 1726)" is quite obviously a photograph of the ancient Egyptian balance in the Cairo Museum illustrated also in Plate 2, and has nothing to do with the footnote on Leupold on p. 91. The reader should also be cautioned against the theoretical discussions, especially the bizarre account of Boyle on p. 113 in which no mention is made of Gassendi or the "corpuscularian hypothesis".

J. N.

* *A History of Science, Technology and Philosophy in the Eighteenth Century*, by A. Wolf. Allen and Unwin, 25*s*. *A Pictorial History of Chemistry*, by Fritz Ferchl and A. Süssenguth. Heinemann, 25*s*.

Birds as Animals

WHEN I was a boy (not so very long ago) there was no ornithological benefactor such as Mr James Fisher. He and his work are typical of a new age in bird watching, an age vastly different from and more exciting than that in which a major ambition was to possess a set of that leisurely and anecdotal work *Morris's British Birds*. Bird watching has now developed from the anecdotal stage to one of scientific observation, and the biologist not primarily interested in birds may discover principles of wide application and significance from a spell of bird watching. Here is a common ground where a scientist, a Shetland crofter and an urban worker watching a reservoir or sewage farm at week-ends can meet in equality and to mutual advantage. Mr Fisher's book should be in the hands of every type of bird watcher, for it is undoubtedly one of the most important works in this field in recent years.

Bird watchers must read as well as watch, but few have the ability or the time to go through

the world's scientific literature and then to co-ordinate results with their own problems. James Fisher has a flair for this work in addition to his original researches in the field, and his book* is in effect a gateway to an immense store of ornithological knowledge, old and new, but especially the new. There are 54 pages of references, arranged under chapter headings; but this is no dry list of books and papers, for each work is adequately discussed in the text and its contribution co-ordinated with others on the same subject.

It is difficult to review adequately a book which is itself a mass of accumulated information. The bird is discussed under the following headings: historians, history, adaptation and habitat selection, variation and distribution, environment, habitat, numbers, migration, colours and display, territory, reproduction, birds and man. Though 802 references to literature are made in the 216 pages of text, Mr Fisher's freshness of approach to his task has brought forth a book without a dull page; indeed, there is something of the lighthearted quality of the bird running through it. The illustrations are apt and the graphic style of the tables conveys much information at a glance. Special mention should be made of the plate facing p. 172, showing kittiwakes and guillemots on the Farne Islands. Many of the birds are in motion, and the picture shows habitat selection of the two species within a crowded area of a few square yards of cliff face, and the extent and type of territorial behaviour of the birds. Mr Fisher has caught in his photograph a moment of the seething activity of early summer at a sea-bird cliff.

The only adverse criticism is made because of the excellence of the book as a constant companion of the bird watcher. There is no good excuse for a book of science being published undated. The book is printed on bulking paper which makes it much larger than need be, for it is essentially a work for hard wear and to carry with you on expeditions as a miniature reference library.

F. FRASER DARLING

Biochemical Balderdash

If, because of some aberration in my sense of the fitness of things, I were to propound an at present untestable hypothesis, e.g. that the moon has a green square on its invisible side, it is unlikely that the astronomers would take me seriously. Conditions, unfortunately, are different in biology. Here the mathematician's purely speculative ideas about protein structure or, as in this book, the engineer's view on pathology and the origin of life, are quite likely to be taken seriously by influential people who know little or nothing of the matter in hand. The publishing of these opinions has been journalistic practice for many years, but it is novel in science. We have been told that Professor Bohr thinks well of Dr Wrinch's views on protein structure and that Professor d'Arsonval likes Lakhovsky's theories; would it not be well if the opinions of Shirley Temple and the Archbishop of Canterbury could be ascertained as well?

This book* has nearly every fault which a scientific treatise can have. It attempts emotional writing; cancer death-rates are irrelevantly emphasized over and over again and are expressed in such forms as "one person dies every eight minutes". Great use is made of words and concepts that are thought likely to lend glamour to the argument; "lines of force", "radiant energy" and even "biomagnomobile substances" are mentioned frequently either undefined, wrongly defined, or in contexts which show that the usual definitions do not apply. Correlations are drawn between variables with no proper analysis of the relevant phenomena; sunspot cycles are correlated with the incidence of diseases carried by insect vectors which breed in water, but no mention is made of the well-known correlation of sunspots with rainfall. This list could be extended enormously, and unprofitably.

Besides these errors in presentation we are given a liberal supply of sketchy accounts of somewhat dubiously controlled "experiments" with the author's "Multiple wave Radiocellulo-oscillator". These culminate in the statement that this machine was responsible for the recovery of the late pope from an illness in 1937, a point which the other accounts of that illness seem to have overlooked.

The translator has added a few confusions of his own but deserves praise for his invective. People like the reviewer are severely reproved as "custodians of infallible doctrines who made up with carping verbiage what they lacked in clarity of vision". That is neatly phrased, but it is doubtful if these occasional gems repay the labour of reading the book. In any case this style of writing is more nimbly managed by Amanda Ros.

N. W. PIRIE

Atomic Structure

For many years Professor Loeb's *Kinetic Theory of Gases* has afforded a lively introduction to what is sometimes a dull and rather formal subject: now a much wider range of topics has provided him with the material

* *Birds as Animals*, by James Fisher. Foreword by Julian Huxley. Heinemann, 12*s.* 6*d.*

* *The Secret of Life. Cosmic Rays and Radiations of Living Beings*, by Georges Lakhovsky. Heinemann, 10*s.* 6*d.*

E. Lewis

THE SWALLOW-TAIL BUTTERFLY (*Papilio machaon*), so called because of the long tips to the lower wings, is found in England only in Cambridgeshire and Norfolk. This photograph, taken at Wicken Fen, shows clearly the bright, attractive markings of the wings. These are yellow, spotted with black, blue, and red, and expand 3½–4 in. The female is larger than the male, but similar in marking.

for a new text-book* for serious students in physics. In roughly 450 pages he has attempted to cover the essential physics of the nucleus and the outer atom, of molecular properties and metallic conduction—to a level "considerably above" that "of the modern American text-books of a survey nature covering the same subject". "A definite classroom need" was obvious to him as a teacher, so he decided to use his own lecture notes, written during a period of six years, to put together the kind of introduction which should furnish the physicist (or the chemist) with "the basis for further study of atomic structure". It is not necessary to say that the result shows the marked individuality of Professor Loeb as an author, nor to affirm his general success in carrying out his original scheme. But his own description of outlook and pedagogic aim is worth quoting in full: "In view of the fact that we can only observe by experiment *aspects* of the fundamental concepts such as the electron, the photon and the nucleus, it is especially desirable that the extent and limitations of these experimental observations be repeatedly brought to the student's attention, for it is only from these that he can understand the nature of the more accurate empirical formulations." This is entirely admirable, and the historical method adopted to attain this end is surely the correct method of approach.

In the detailed carrying out of the scheme, however, there are more causes for complaint. In many places the amount of detail appears unnecessarily great: a more rigorous introduction than that provided by the usual survey books could certainly have been written without the elaboration which is frequently found. Then the writing, too, often shows relics of the lecture-note model (in the original American idiom) and abounds in colloquial expressions and abbreviations, or, when it is not abbreviated, it runs to looseness and turgidity: "Theories involving the existence of α-, etc., particles in nuclei and omitting them as units in the nuclei entirely are equally successful, although the tendency seems to-day to be toward the acceptance of the non-existence of α-particles in the nucleus until just before their emission" (p. 125). "Thus, according to Avogadro's rule, a mole of any gas has the same number of molecules: to wit,

$$2{\cdot}69 \times 10^{19} \times 22{,}414 = 6{\cdot}023 \times 10^{23}$$

molecules at 0° C. and 760 mm." (p. 335).

English students will often wish to refer to this book, but they ought to realize that it was not written to meet their particular needs, so they must not grumble if their wants happen to be overestimated in some places and to receive scant satisfaction in others. Also, they should be warned again not to reproduce the author's style in their answers to examinations.

N. FEATHER

* *Atomic Structure*, by Leonard B. Loeb. John Wiley and Sons, Inc.; Chapman and Hall, Ltd., 22*s*. 6*d*.

The Perception of Light

INTO this little book,* the Lecturer on Physics to the Imperial College of Science compresses a surprisingly exhaustive account of the latest researches into many subjects related to vision and illumination. He treats of the eye's physiology, the relative advantages of various lighting conditions and light-sources, has a section on colour-blindness, and one on the causes and evils of glare; then he deals with the difficult problem of the stimulus-sensation relation, with accounts of many experiments, mostly made with apparatus designed by himself. He upholds the Duplicity Theory, believing that (as first shown by van Kries and Dr Ladd-Franklin) the cones of the retina operate both the photopic and the colour-perception mechanism, whereas the rods are responsible for scotopic and achromatic vision.

Dr Wright has measured the effects on vision of adaptation to light intensities and colour changes; the difficulties of such studies are increased by the impossibility of accurately measuring sensations. The receptors in the retina, he finds also, probably vary slightly, at any instant, among themselves—also any receptor and nerve fibre may vary slightly in sensitivity from moment to moment. All of which seems to make Fechner's law (sensation varies as log stimulus) rather out-of-date. Dr Wright accounts for the unreliability of relative "values" in photography by showing that a 1 : 1 relation cannot always hold between the intensities of the scene and those of the reproduction. Here compromise must come in. Even greater difficulties occur in cinematography and in television, owing to the pictures being seen in the centre of a dark field. M. B.

The Australian Aborigines—How to Understand Them

WITH this book,† Professor A. P. Elkin provides an introduction to the study of the social organization and the spiritual life of the aborigines of Australia.

As Professor Elkin justly claims, there is an ever-growing desire on the part of Australians to treat the surviving natives with justice and to help them to rise in the cultural scale—"if only

* *The Perception of Light*, by W. D. Wright. Blackie, 6*s*.

† *The Australian Aborigines—How to Understand Them*, by A. P. Elkin. Angus and Robertson, Sydney, 8*s*. 6*d*.

we knew how". It is the objective of this book to provide this knowledge, to show the way. Its aim is threefold: to help the general public who would like to know more about the aborigines; for the administrative officer and the missionary whose work lies among these people; and also for the scientifically minded man who wishes for an introduction to the more detailed monographs on the aborigines of Australia.

The chapters on Totemism and on Social Organization on the family and other relationships are admirable and form the best part of the book. Professor Elkin has succeeded very well in dealing with the intricacies of the specialized totemism and social organization of these natives, but it is a pity that he has permitted his horizon to be limited almost to the bounds of his own school.

In the approach to the practical needs of the aborigines the author is less convincing, and in his theoretical discussions the need for practical experience of the problems of administration are apparent. And, after all, is the actual problem of the aborigine in Australia so mysterious a business, or may the plain man be pardoned if he harbours just the least suspicion that many of the discussions on the "Problem of the Aborigine" merely beg the question, that Professor Wood Jones was not so very wide of the mark when he observed that the problem of saving the Blackfellow from extinction as a race presented no insuperable difficulties, always provided that one had a Government that really wanted to do so?

D. F. T.

Medicine and Health

BOTH of these books* are by American authors. Both deal with certain aspects of modern medicine; the first is derived mainly from a series of articles in the American press, the other is based on the Vanuxem Lectures given at Princeton University. *Builders of Health* is thus of a more popular character.

In an account of medical matters written for non-medical readers, one looks for three things. First, it should be interesting without being sensational. Secondly, it should be intelligible to the layman without being written in journalese or slang. And lastly, it should be as accurate as is compatible with the use of non-technical language. Mr Dietz, who, as well as being a Lecturer in Science, is a Pulitzer prize-winner in journalism, has achieved all these desiderata. His book is an admirably lucid account of the present-day position in several branches of physiology, biochemistry and medicine. It is in such chapters as those on "The Magic of the Glands" and "Safeguarding Motherhood" that the absence of cheap sensationalism is most to be appreciated. And in the chapters on "The Magic of Nerves" there is an able, accurate and extremely clear account of recent work in a most difficult branch of physiology.

There are some forty chapters in this book, all packed with information, yet the whole is most readable. Nor is the reader easily sated, as so often happens with a series of essays of this type. A point which will be much appreciated by readers in this country is that, for the English edition, many figures and examples have been added or altered so as to refer to conditions here. Altogether, a very successful book.

Dr Riesman, the author of *Medicine in Modern Society*, is Professor of the History of Medicine and Emeritus Professor of Clinical Medicine at Princeton University. The majority of the essays in this book are concerned with the development of modern medicine, but the author also discusses many of the problems of the social relationships of medicine. There is a growing feeling that more stress should be laid on the preservation of health as distinct from the treatment of disease, and Dr Riesman advocates periodical medical examination for all, but especially for the middle aged. He stresses, however, that though the diagnosis and knowledge as to treatment may be in the hands of the medical profession, their adequate application is a matter for society as a whole. "Better medical care and more doctors", writes the author, "is only part of the answer. The conditions creating poverty, degeneration, inertia, hopelessness, the existence of which is a powerful indictment against our boasted civilization, must be removed." Dr Riesman is strongly in favour of some form of socialized medicine, a scheme which appears to have raised an even greater controversy in the United States than in this country.

There are intriguing accounts of the vitamins and X-rays, of virus disease and modern views on the neuroses. The reader will perhaps be slightly irritated by somewhat detailed explanations of certain obvious terms while many technical phrases are left unexplained. He will be surprised to see the English diploma, D.P.H., written as "Dr P.H., Doctor of Public Health". Another error is made in writing of the dangers in blood transfusion. According to Dr Riesman, they may be due either to the effect of the donor's serum on the blood cells of the recipient or to the action of the serum of the recipient on the blood cells of the donor. In actual fact, as every medical student knows, only the latter danger exists. Such details detract from an otherwise readable and interesting book.

JOHN YUDKIN

* *Builders of Health*, by David Dietz. George Allen and Unwin. 12*s*. 6*d*. *Medicine in Modern Society*, by David Riesman. Princeton University Press, $ 2.50.

Astronomy for Everyman

On the whole this book* is a good introduction to astronomy for the man in the street. The authoress is the daughter of one who was a distinguished figure in the astronomical world. Mary Proctor in her popular astronomical works has carried on with the good work begun by her father—what amateur astronomer of the older school has not read the late Richard Proctor's *Half Hours with the Telescope*?

There is no doubt about the appeal which the photographs taken at the world's greatest observatories offer. *Astronomy for Everyman* includes a goodly collection of the best. They illustrate admirably the text which deals with novae, double stars, nebulae and globular clusters, the origin of the constellations, and especially those portions of the heavens visible in our northern hemisphere. There is a chapter on celestial photography and chart making, and star drift is also dealt with as may be expected, for the authoress, no doubt, has first-hand knowledge of this field in which Richard Proctor was such a great investigator. Meteorites and their story occupy a large portion of the latter part of the book and there are detailed descriptions of the great meteor crater in Arizona and the huge Russian meteorite.

Miss Proctor rather stresses the meteoric theory of the formation of the lunar craters. It should have been emphasized that there is no definite proof forthcoming for *any* theory as yet, although her father was probably the first to place the meteoric theory in the strong position it holds.

There are a few obvious misprints and errors which, however, do not detract from the book as a popular treatise. For instance, the reviewer is not inclined to agree with the statement on p. 103 that the Great Nebula in Orion, when observed by the naked eye, appears to cover an area larger than the full moon. To most people, even those with the keenest sight, the Nebula looks rather like a fuzzy star. Also, one cannot help criticizing the "wandering" type of sentence that occasionally occurs. When one has to read a sentence twice to catch its real meaning it detracts from the pleasurable digestion of facts.

But these are minor criticisms; the book is one in which enthusiasm for astronomy is transmitted to the reader, and the quotations from poetic verse descriptive of astronomical phenomena are apt and full of charm. It cannot be doubted that this book will whet the appetite of the reader.

C. G. JAMES

* *Astronomy for Everyman*, by Mary Proctor. Scientific Book Club, 3*s*. 6*d*.

In last month's issue of *Discovery* the photographs illustrating Mr Gregory Walker's article on "How Stained Glass is Made", were reproduced by the permission of Messrs James Powell and Sons (Whitefriars), Ltd. Those in Mr Lorant's "The Size of the Universe" were reproduced from U.F.A., Ltd.

Select List of Books Received by *Discovery*

(*Mention in this list does not preclude review*)

East of Athens. Eric Gifford. (Travel Book Club, 3*s*. 6*d*.)

An Eye-witness of Mexico. R. H. K. Marett. (Oxford University Press, 8*s*. 6*d*.)

By Bus to the Sahara. Gordon West. (Travel Book Club, 3*s*. 6*d*.)

Men and Cities. S. Elliott Napier. (Angus and Robertson, 7*s*. 6*d*.)

Our Back Yard. Henry Hall. (Angus and Robertson, 5*s*.)

Wild Flowers of Australia. Thistle Y. Harris. (Angus and Robertson, 8*s*. 6*d*.)

Butterflies and Moths of the Wayside and Woodland. W. J. Stokoe. (Warne, 7*s*. 6*d*.)

Inventions and Their Uses in Science Today. S. Stafford Hatfield. (Pitman, 3*s*. 6*d*.)

Modern Electric Clocks. Stuart F. Philpott. (Pitman, 7*s*. 6*d*.)

Nature and the Rambler. W. R. Calvert. (Nelson, 2*s*.)

Man the Slave and Master. Mark Graubard. (Dent, 10*s*. 6*d*.)

The Secret of Life. Georges Lakhovsky. (Heinemann, 10*s*. 6*d*.)

The Birth and Development of Geological Sciences. Frank Dawson Adams. (Baillière, Tindall and Cox, 22*s*. 6*d*.)

Physics of Today. J. A. Clark, F. R. Gorton, F. W. Sears. (Constable, 8*s*. 6*d*.)

Report on The Gas Industry in Great Britain. (P.E.P., 10*s*. 6*d*.)

Wild Animals in Britain. Frances Pitt. (Batsford, 8*s*. 6*d*.)

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